OCCUPATIONAL HAZARDS OF COMPOSTING

Exposures, protection, and prevention

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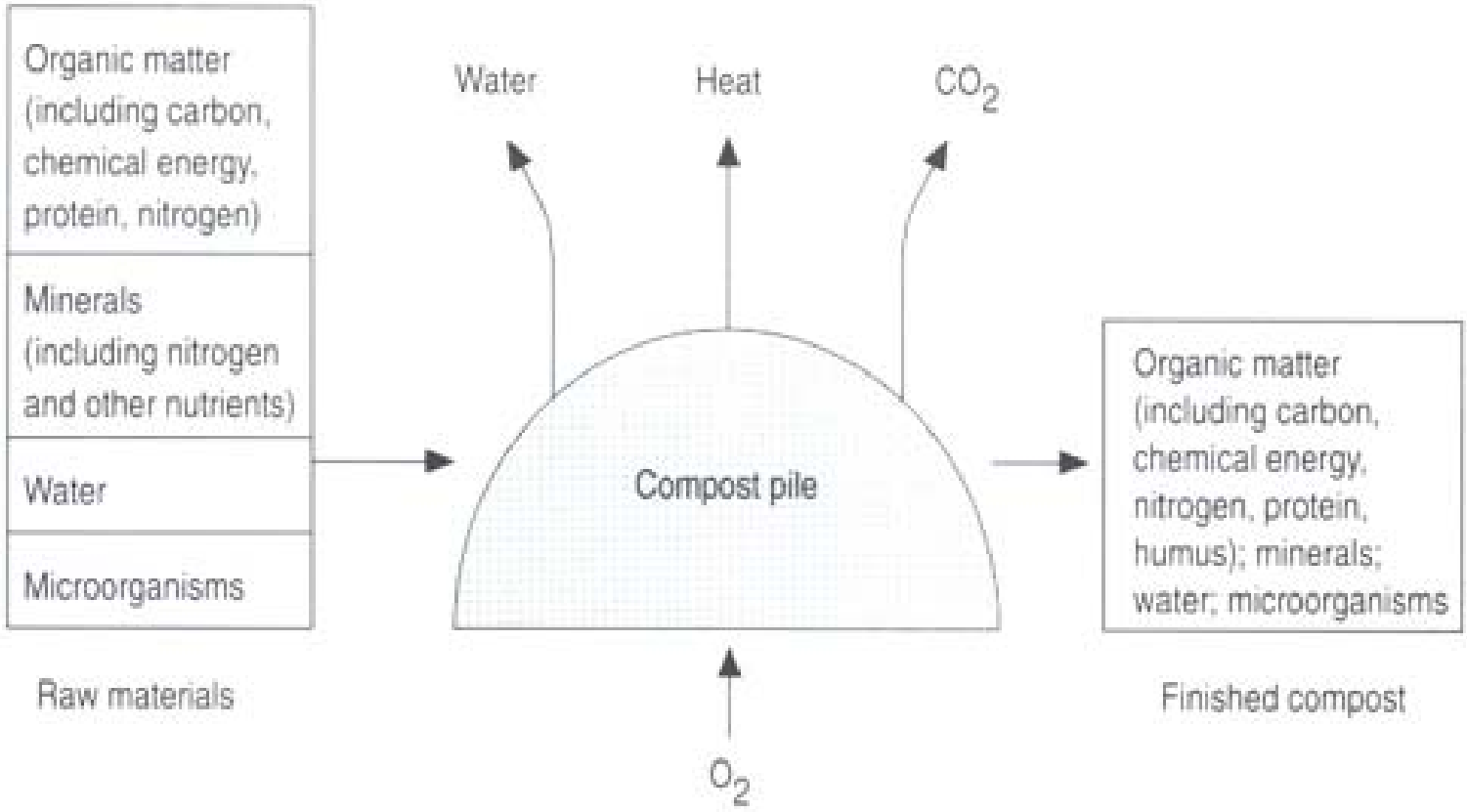
CORNELL ilr School of Industrial and Labor Relations

"It's not good, ma'am. . . . He's got field mice."



The carbon, chemical energy, protein, and water in the finished compost is less than that in the raw materials. The finished compost has more humus. The volume of the finished compost is 50% or less of the volume of raw material.

Figure 2.1
The composting process.

Source: Rynk, R. 1992. *On-Farm Composting Handbook.* National Resource, Agriculture, and Engineering Service. Cooperative Extension. Ithaca, NY.

Principal hazards – an overview

- Chemicals released during decomposition
  - Some regulated by OSHA; but not the toxins
- Heavy and other metals: OSHA regulations
- Dust: no regulations for organic dusts
- Microorganisms: no regulations
- Noise: OSHA regulation

Source: Johanning, E. 1999. An overview of waste management in the United States and recent research activities about composting related occupational health risk. *Schriftenr ver Wassen Boden Lufthyg. 104:* 127.

Principal hazards – an overview

- Climatic conditions: heat or cold stress; NIOSH/ACGIH recommendations
- Accidents and trauma (including sharp objects in compost): OSHA regulations
- Ergonomic factors: OSHA advisories; NIOSH/ACGIH recommendations

Source: Johanning, E. 1999. An overview of waste management in the United States and recent research activities about composting related occupational health risk. *Schriftenr ver Wassen Boden Lufthyg. 104:* 127.

Risk factors of composting

Dependent upon:

- What is being composted?
  Feedstocks and bulking agent

- How do you do it?
  High-quality operation
  Poor-quality operation
  Process failure

What is being composted?

Feedstocks: (alone or mixtures)

- Yard wastes: leaves, grass, brush, trimmings
- Food wastes
- Agricultural wastes: plants, animals, manure, bedding
- Industrial wastes: paper, food wastes, ?????
- Sewage sludge (biosolids)

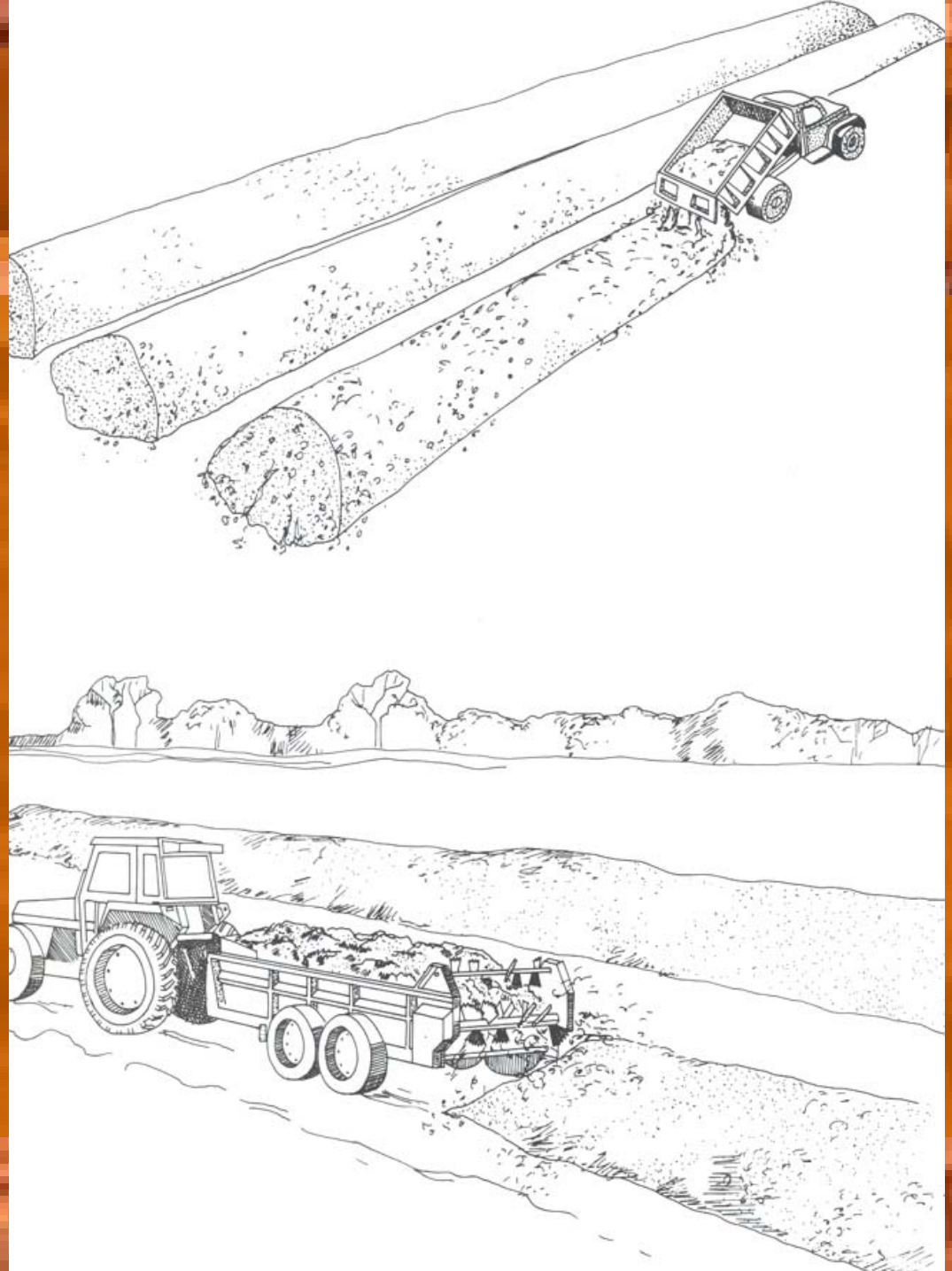
Bulking agent: wood chips, sawdust, other

How do you do it?

- Windrow or static pile or in-vessel or vermicomposting or other(?)
- Containers or enclosures
- Feed rate and mixing
- Temperature: mesophilic, thermophilic
- Duration of cycle: when is it considered finished?

Source: Rynk, R. 1992. *On-Farm Composting Handbook.* National Resource, Agriculture, and Engineering Service. Cooperative Extension. Ithaca, NY.

Windrows



Aerated static pile

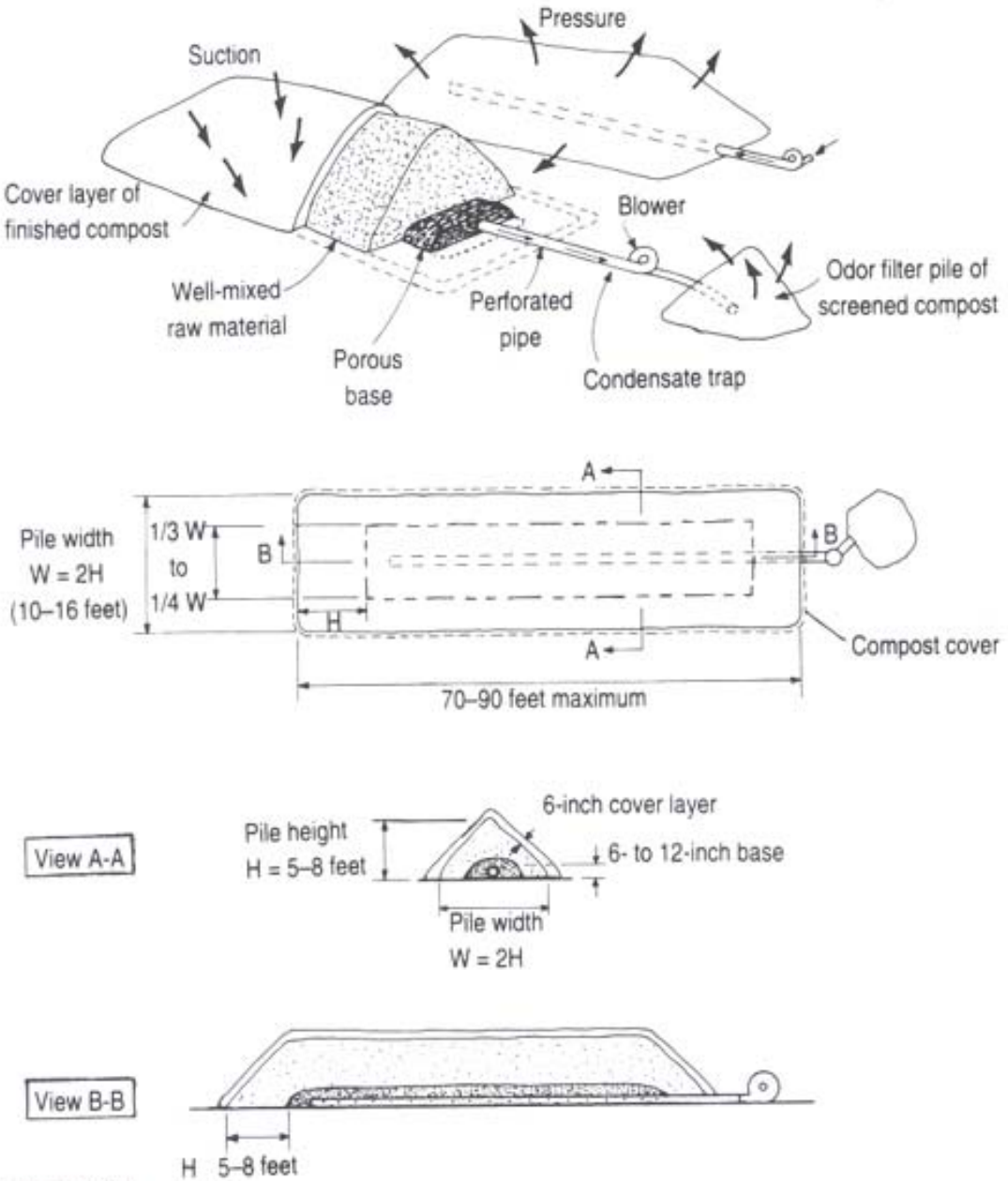
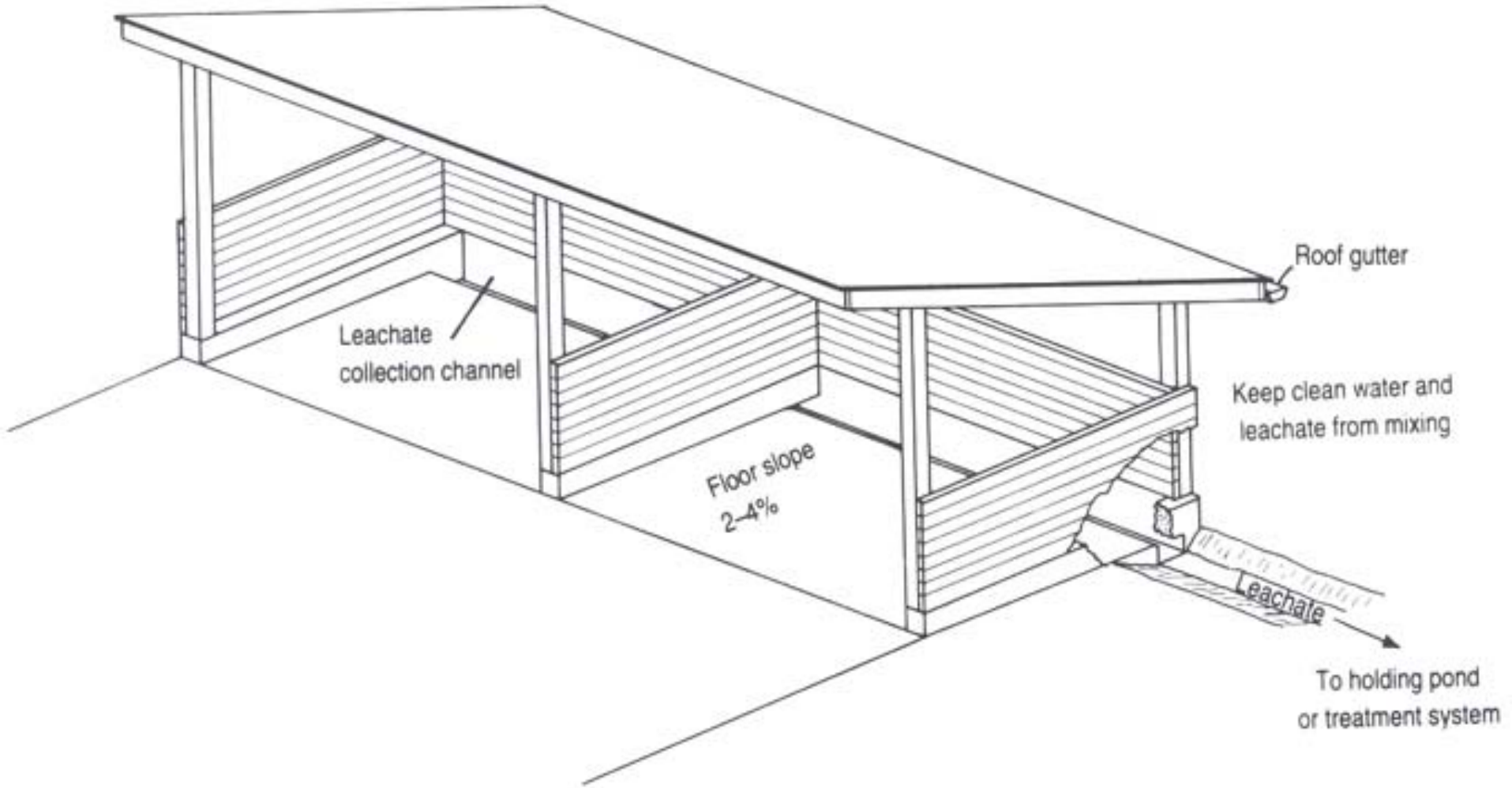


Figure 4.8
Aerated static pile layout and dimensions.

Adapted from Willson, *Manual for Composting Sewage Sludge by the Aerated Pile Method.*

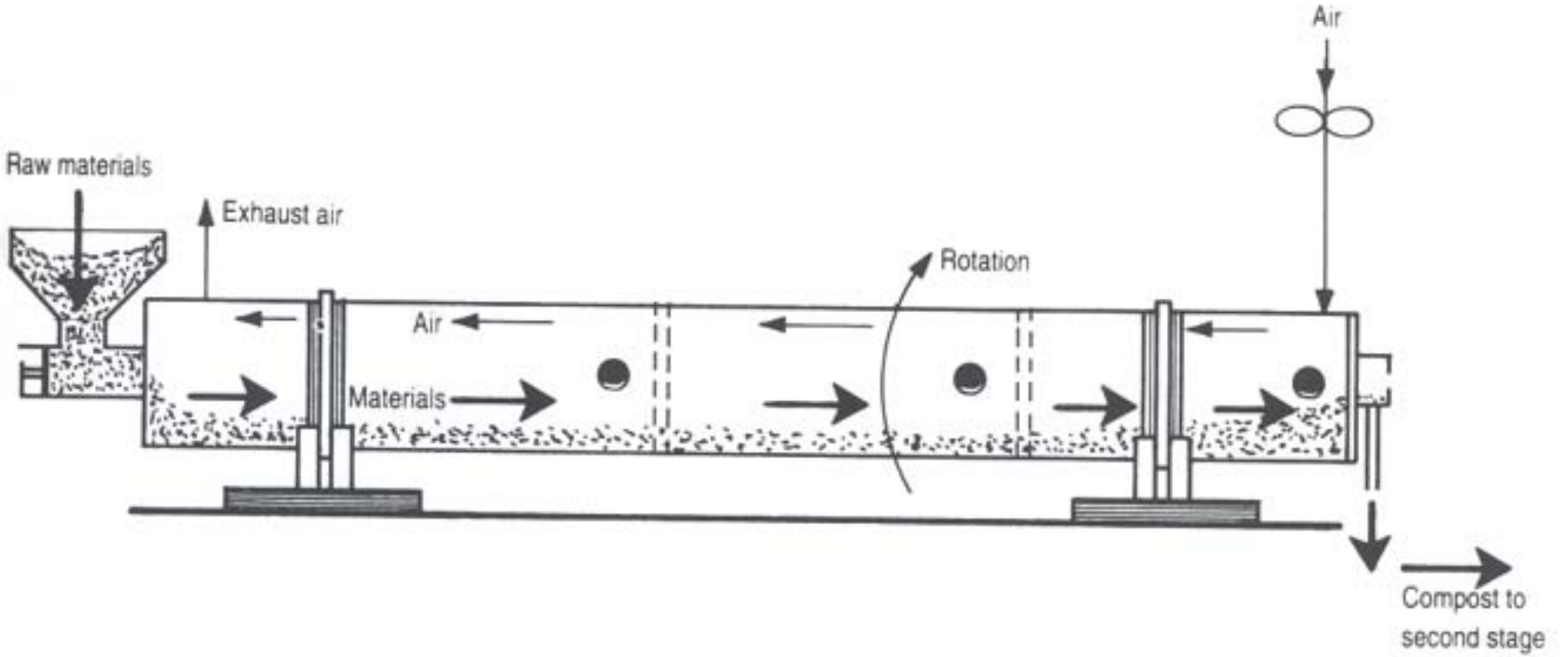
Source: Rynk, R. 1992. *On-Farm Composting Handbook.* National Resource, Agriculture, and Engineering Service. Cooperative Extension. Ithaca, NY.

Compost bins



Source: Rynk, R. 1992. *On-Farm Composting Handbook.* National Resource, Agriculture, and Engineering Service. Cooperative Extension. Ithaca, NY.

Rotary drum composter



Source: Rynk, R. 1992. *On-Farm Composting Handbook.* National Resource, Agriculture, and Engineering Service. Cooperative Extension. Ithaca, NY.

Agitated bed composter

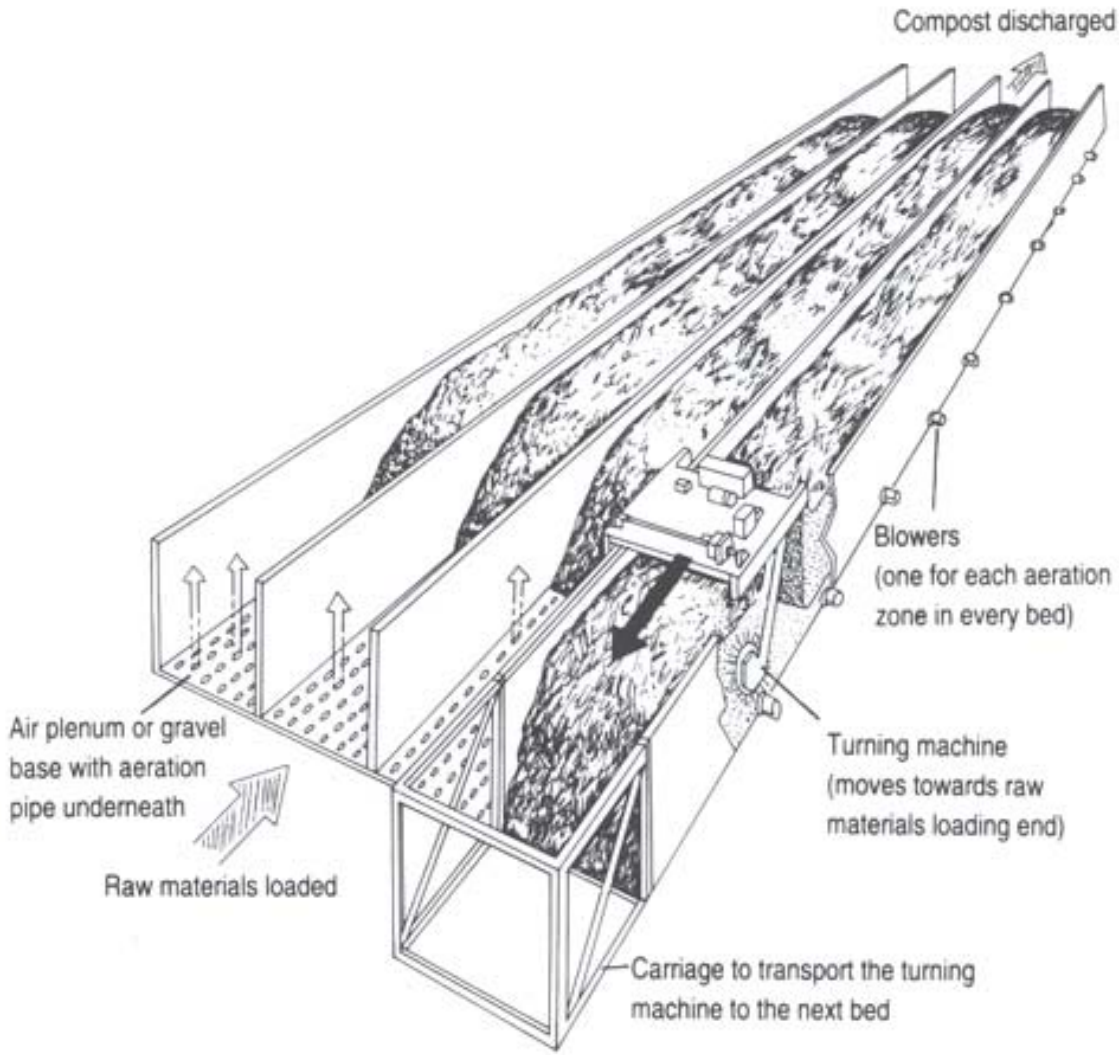


Figure 4.15
Rectangular agitated bed composting system.
Adapted with permission from Royer Manufacturing.

Source: Rynk, R. 1992. *On-Farm Composting Handbook.* National Resource, Agriculture, and Engineering Service. Cooperative Extension. Ithaca, NY.

Exposure could occur during…

- Starting or adding material
- Grinding, chipping
- Mixing or turning
- Screening
- Packaging of finished compost
- Application and use of finished compost
- Spills
- Leachate and its storage (on-site)

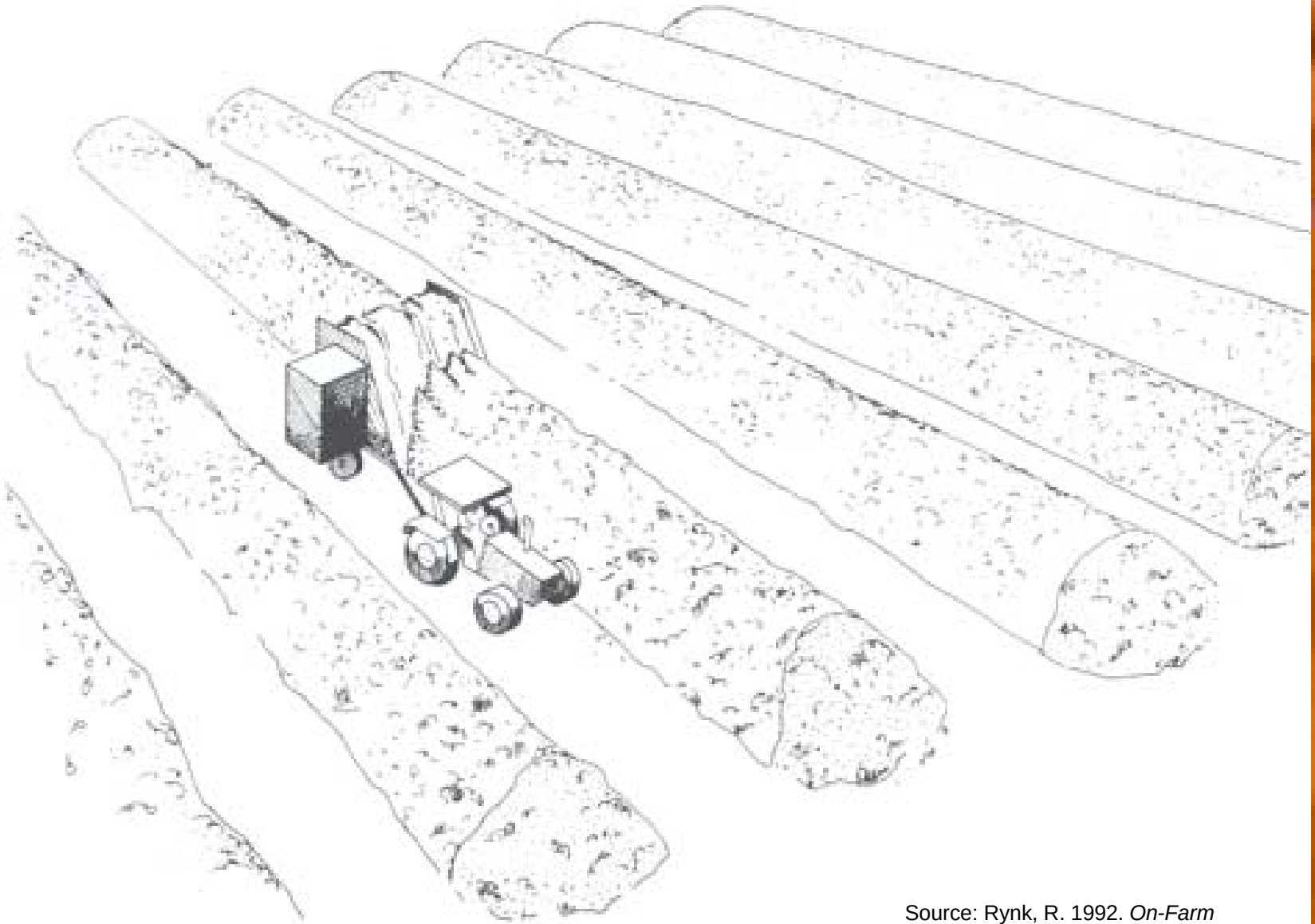


Figure 4.1
Windrow composting with an elevating face windrow turner.

Source: Rynk, R. 1992. *On-Farm Composting Handbook.* National Resource, Agriculture, and Engineering Service. Cooperative Extension. Ithaca, NY.

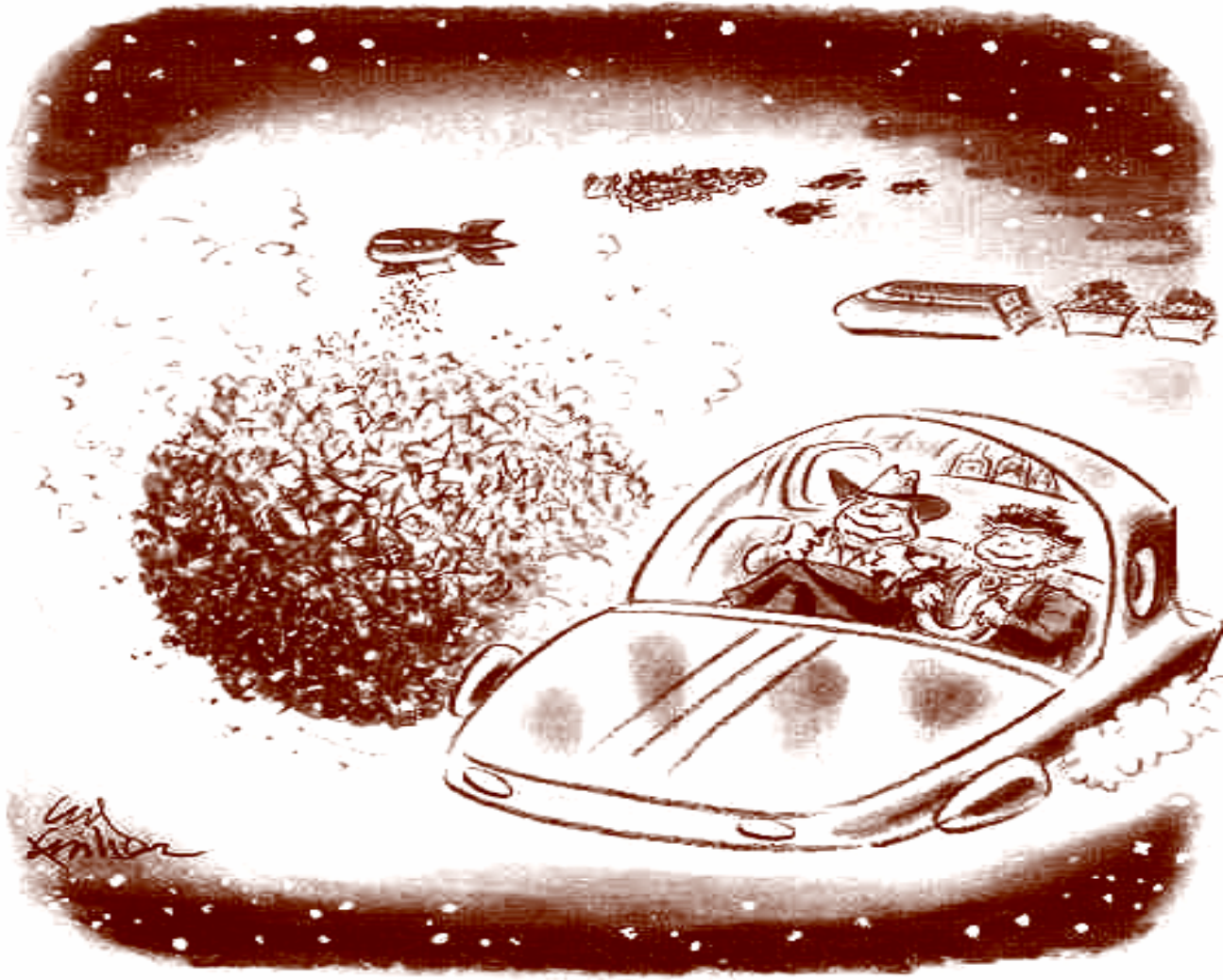
Figure 4.3
Turning windrows using a bucket loader.

Source: Rynk, R. 1992. *On-Farm Composting Handbook.* National Resource, Agriculture, and Engineering Service. Cooperative Extension. Ithaca, NY.

Exposure during composting…

…could have enormous variability because of all of these factors.

TOMORROW'S ASTRONOMY:



DETRITUS MAJOR

THE LITTLE PLANET THAT GREW RICH BY OFFERING ITSELF AS A GALAXY-WIDE GARBAGE DUMP

Principal hazards

- Chemicals released during decomposition
  - Some regulated by OSHA; but not the toxins
- Heavy and other metals: OSHA regulations
- Dust: no regulations for organic dusts
- Microorganisms: no regulations

Source: Johanning, E. 1999. An overview of waste management in the United States and recent research activities about composting related occupational health risk. *Schriftenr ver Wassen Boden Lufthyg. 104:* 127.

Routes of exposure for chemicals and biological agents

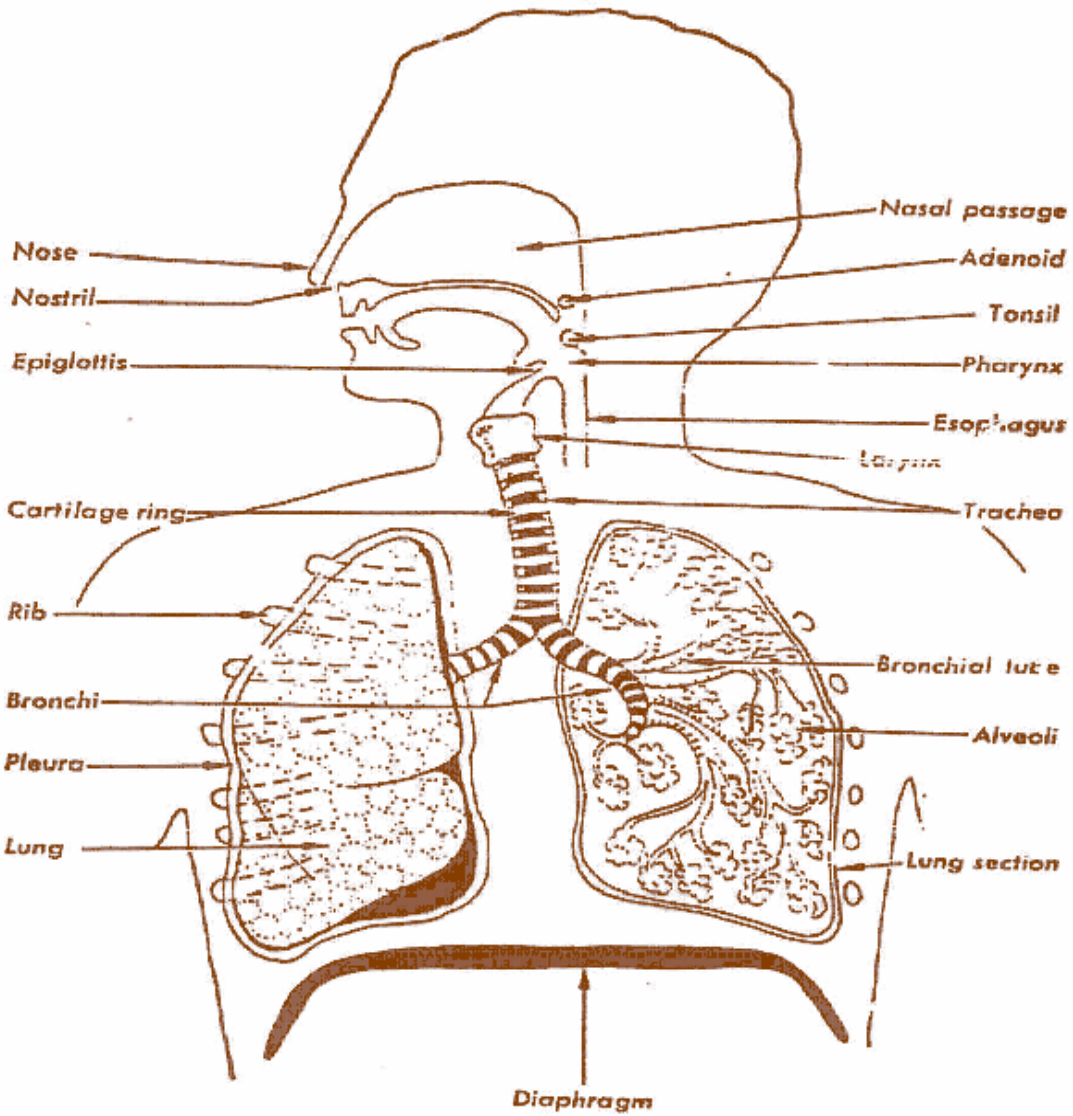
Inhalation

Skin/eye contact or absorption

Injection (through the skin, including cuts, jabs, and high-pressure injection injuries)

Ingestion (typically, hand-to-mouth contact)

THE RESPIRATORY SYSTEM



WHEN MATERIALS ARE INHALED, WHAT HAPPENS TO THEM?

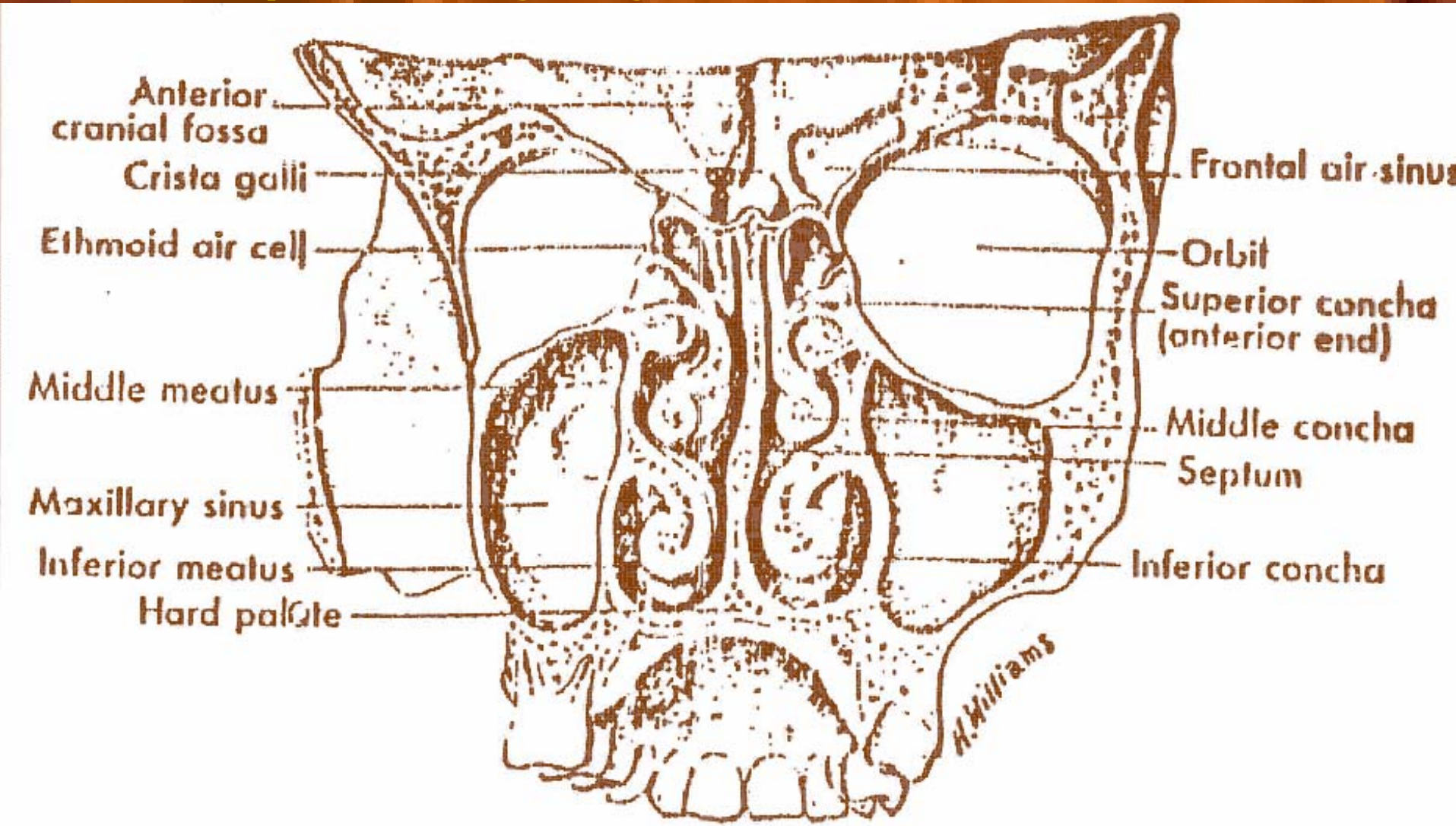
Particles penetrate into the respiratory tract depending upon their size…

…the smaller the particle, the deeper into the lung it can go.

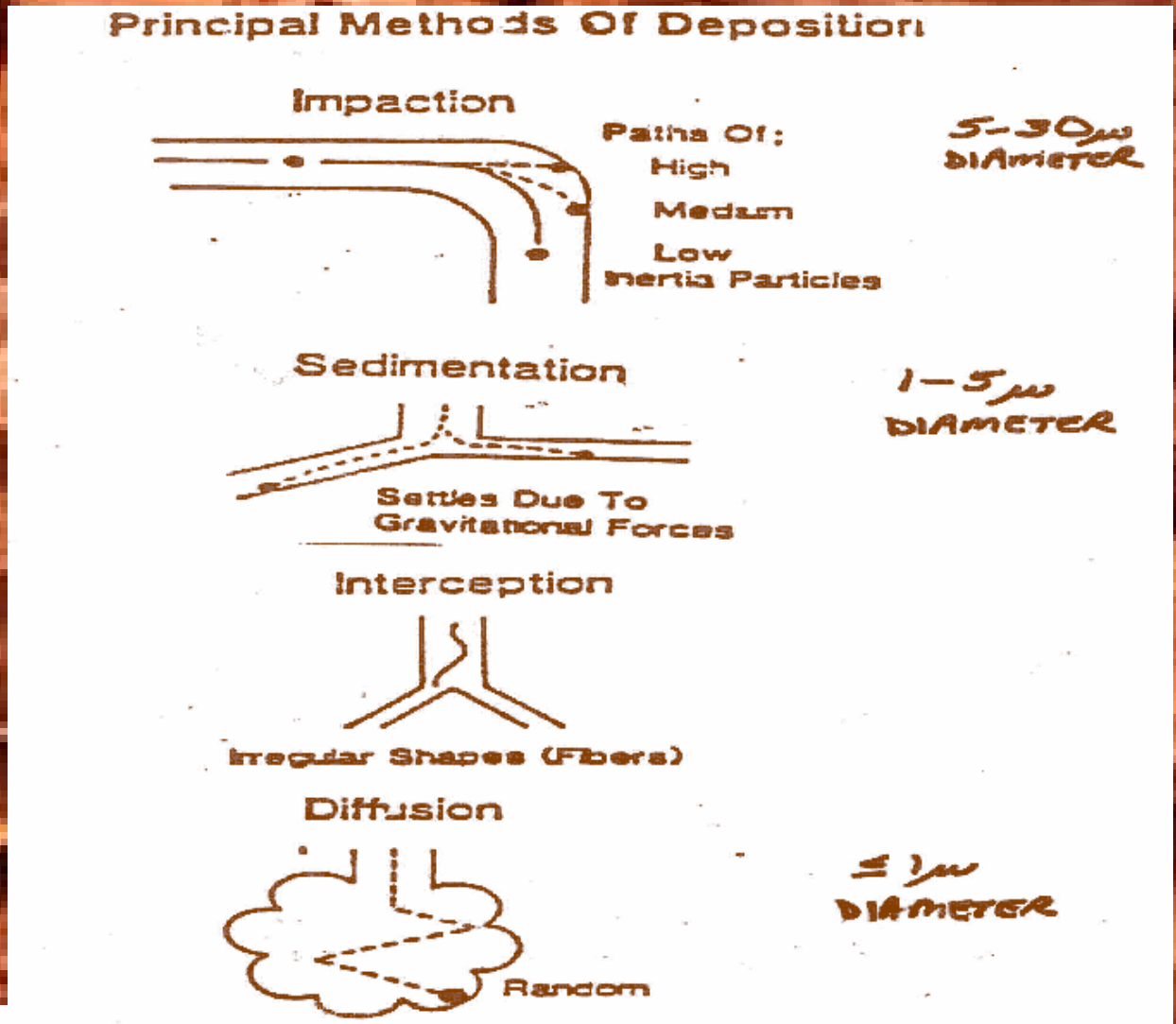
Gases reach areas of the respiratory tract depending upon their water solubility…

…the less water-soluble a gas is, the deeper into the lung it can go.

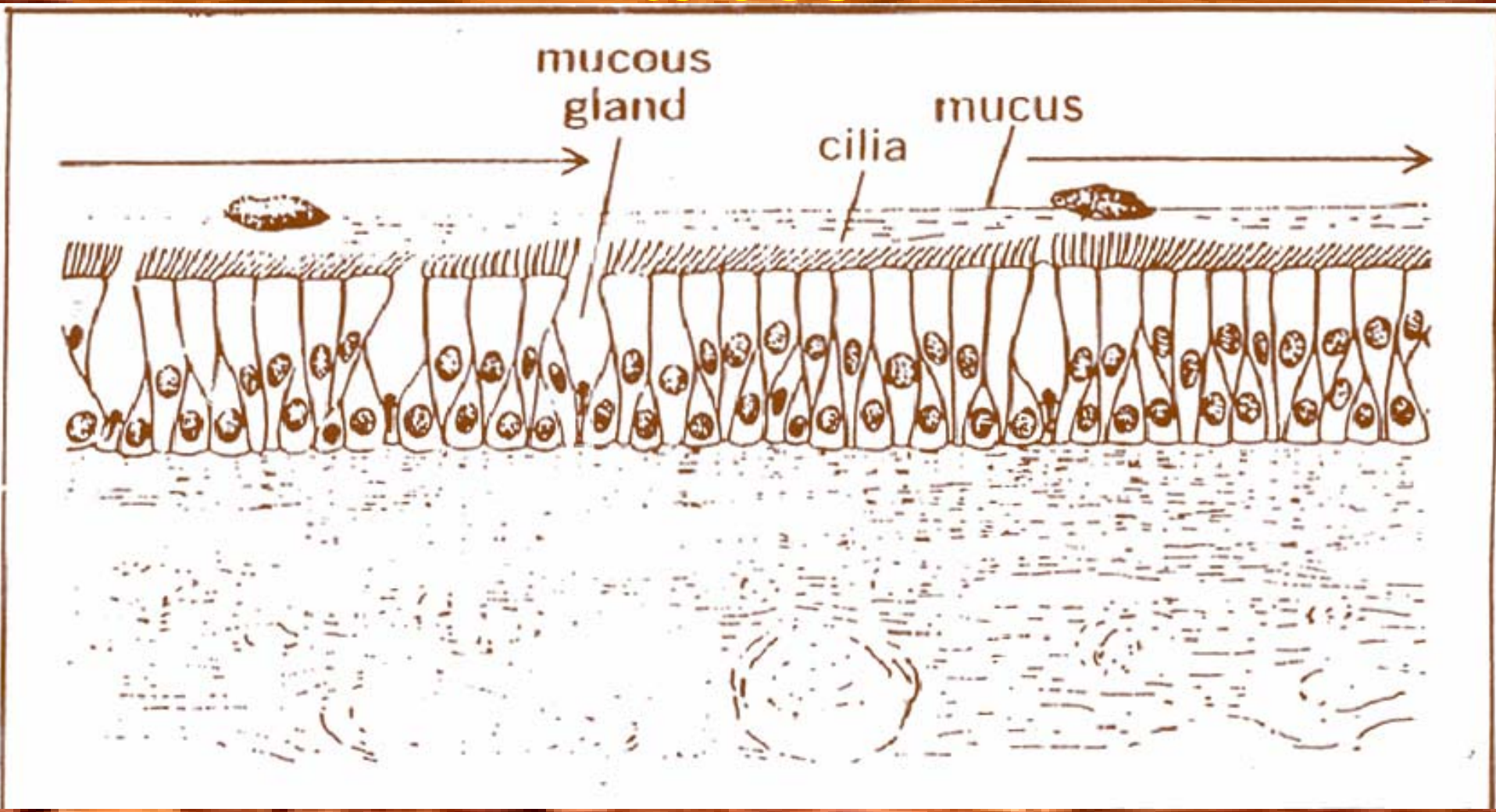
Respiratory system -- sinonasal



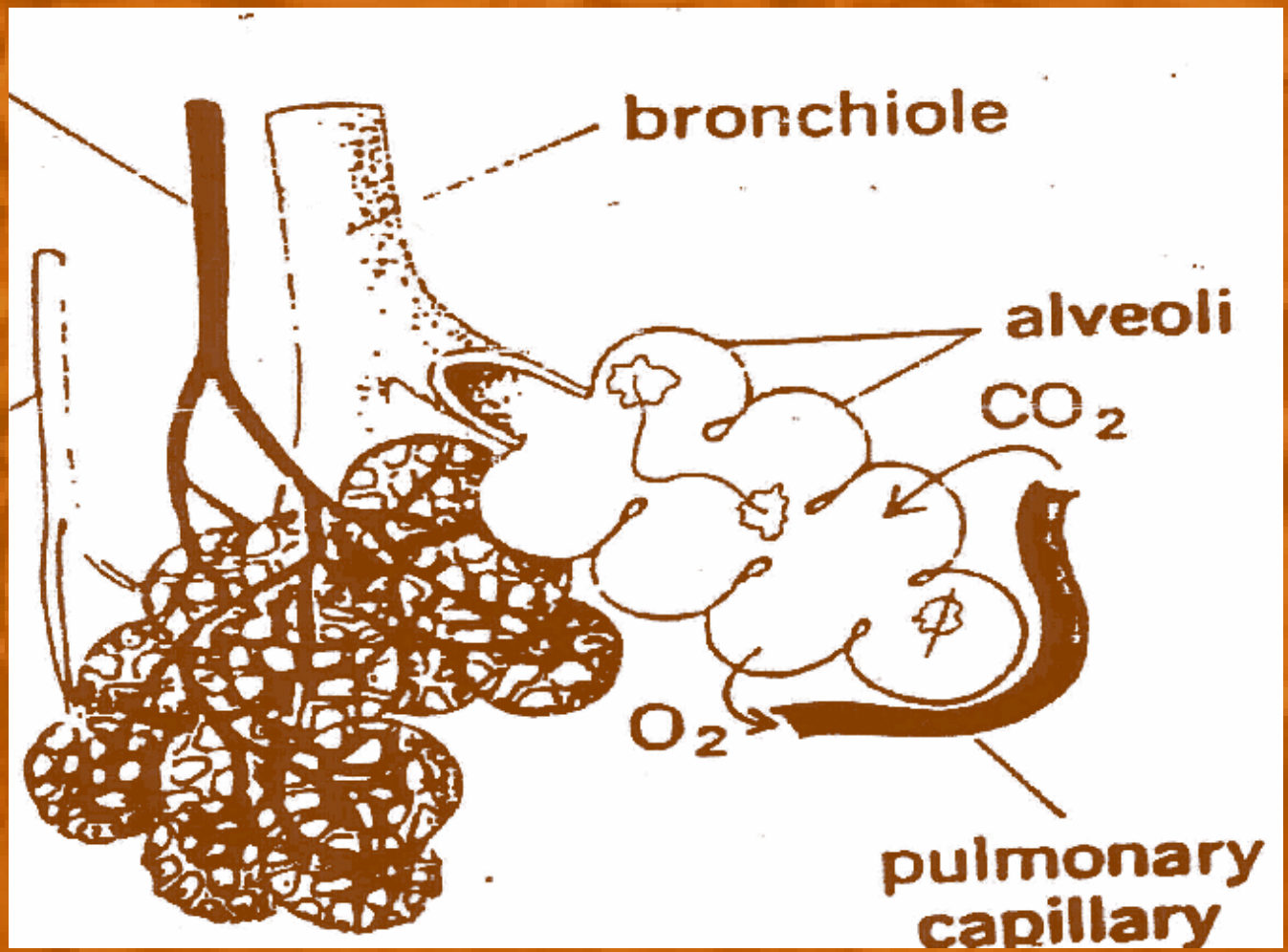
Respiratory system

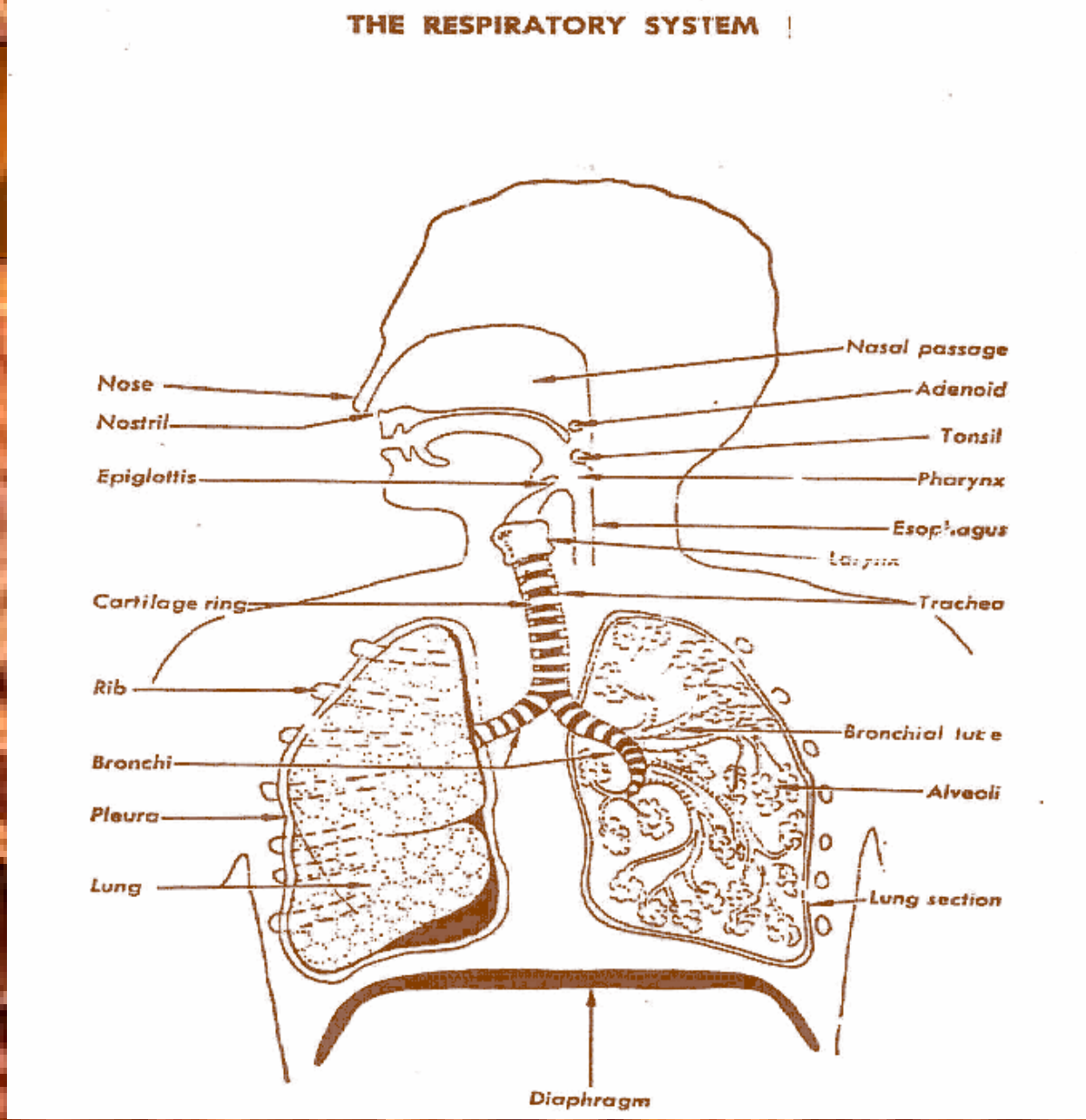


Respiratory system – bronchial tubes

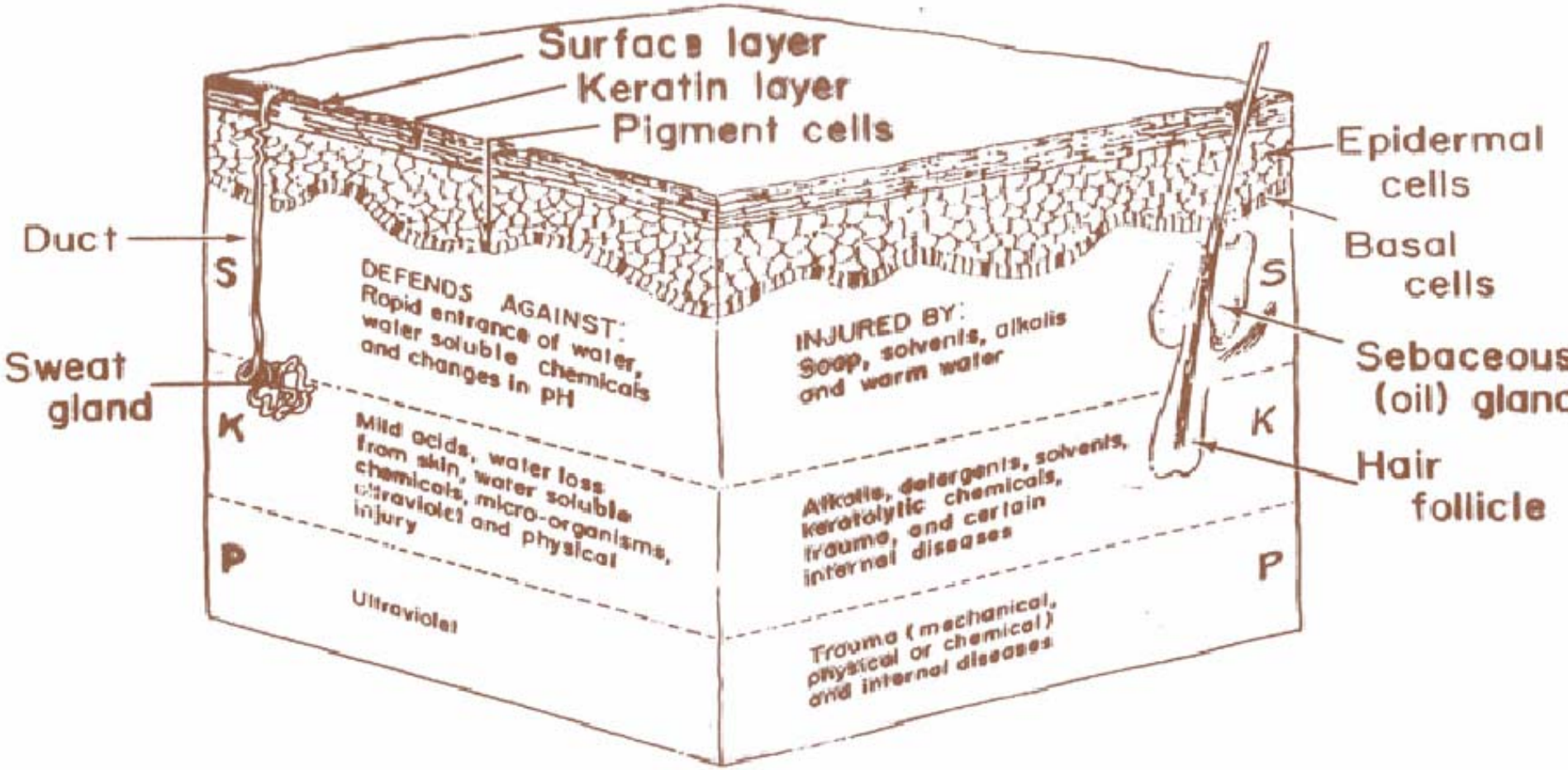


Respiratory system -- alveoli




THE RESPIRATORY SYSTEM
Nose
Nostril
Epiglottis
Cartilage ring
Rib
Bronchi
Pleura
Lung
Nasal passage
Adenoid
Tonsil
Pharynx
Esophagus
Trachea
Bronchial tube
Alveoli
Lung section
Diaphragm

Skin



Note use here for "water solubility."

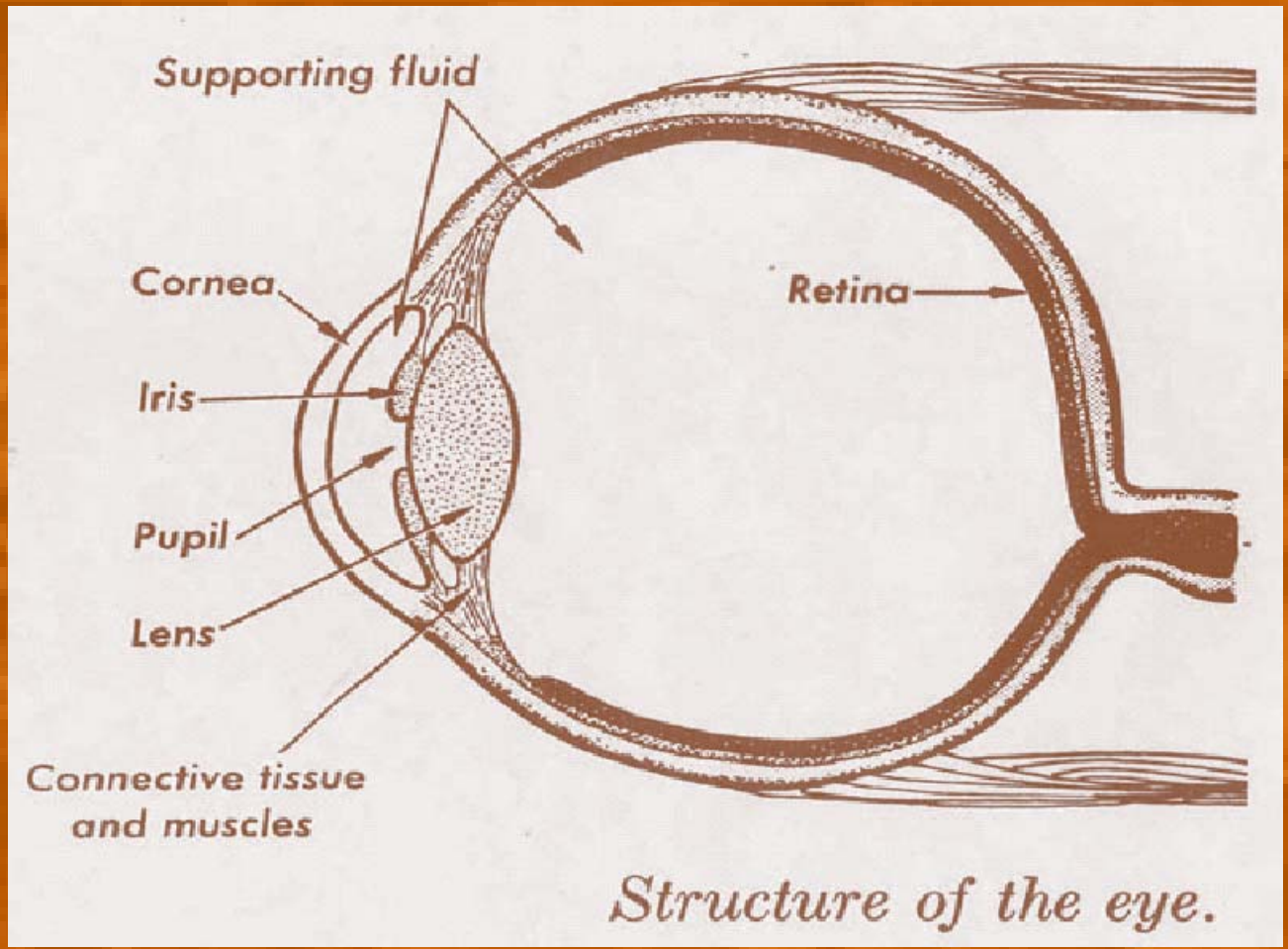
RELATIVE REGIONAL PERMEABILITY OF HUMAN SKIN

Example: topical ^{14}C-hydrocortisone

LOCATION ON BODY	RELATIVE RATE
Plantar foot arch	1
Palm	6
Ventral forearm	7
Dorsal forearm	8
Back	12
Scalp	25
Axilla (armpit)	26
Forehead	43
Jaw angle	93
Scrotum	300

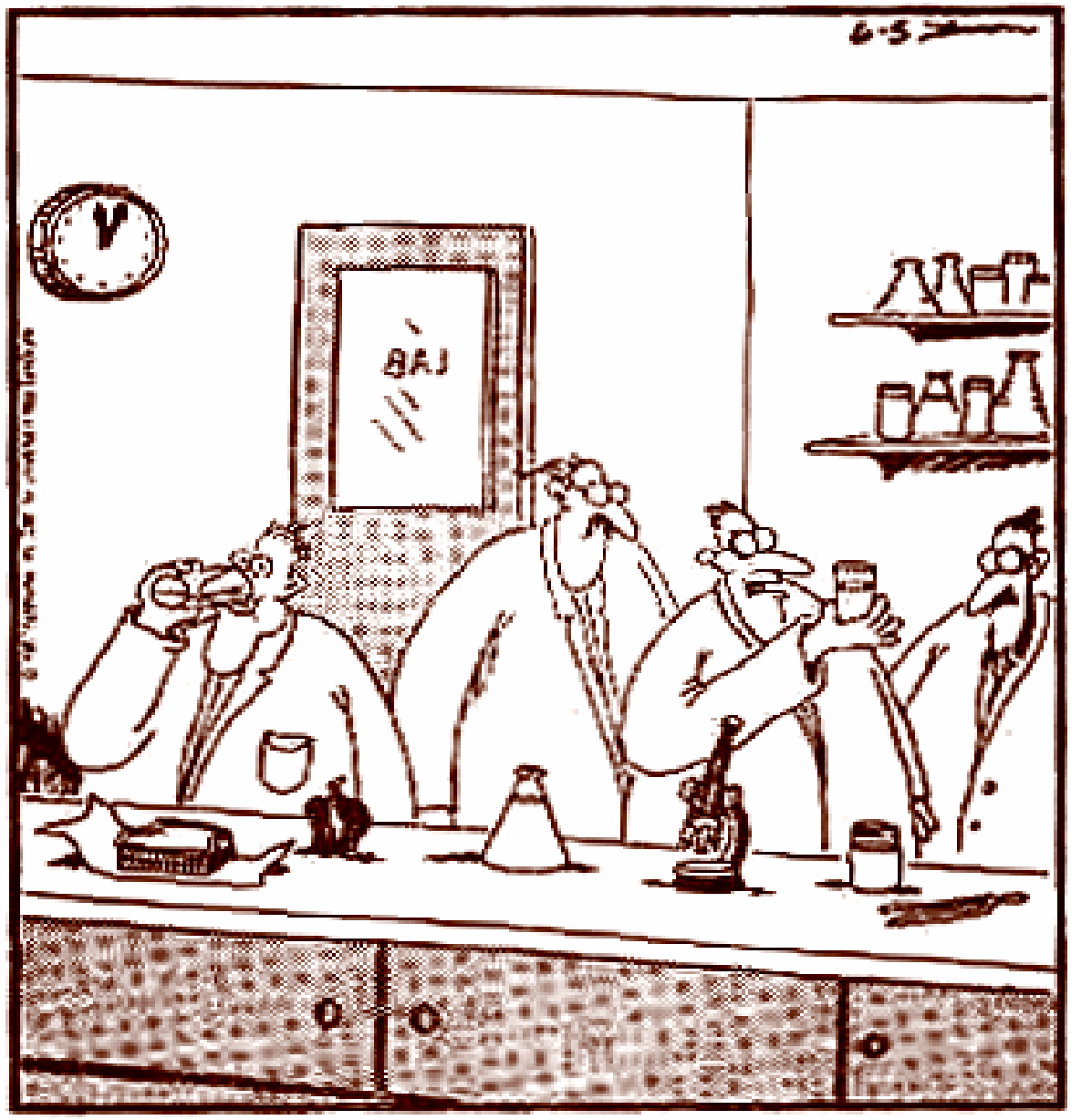
Source:
Feldmann, R. J. et al. 1969. Absorption of some organic compounds through the skin in man. *J. Invest. Dermatol. 54*: 339.

Structure of the eye



Note use here for “water-solubility.”

THE FAR SIDE



"What the? ... This is lemonade! Where's my culture of amoebic dysentery?"

Overall, studies of compost workers indicate:

Cases of respiratory illnesses and dysfunction:

- Reduced lung function during the work shift.
- Inflammation: congested nose, sore throat, dry cough; tends to subside several hours after end of exposure.
- Tracheobronchitis

Overall, studies of compost workers indicate:

Cases of respiratory illnesses and dysfunction:

- Chest tightness
- Organic toxic dust syndrome -- toxic alveolitis (fever, flu-like feeling, joint aches)

(Potential healthy worker effect possible in one or more studies where some of the original workforce left the facility because of respiratory diseases.)

Overall, studies of compost workers indicate:

Inflammation of the eyes: redness and tears

Skin: irritations, infections

Increased antibody (IgG) concentrations against fungi and actinomycetes

Gastrointestinal symptoms: nausea, vomiting, diarrhea

Sigsgaard, T. et al. 2000. Cytokine release from the nasal mucosa and whole blood after experimental exposures to organic dusts. *Eur. Respir. J. 16*: 140. Bunger, J. et al. 2000. Health complaints and immunological markers of exposure to bioaerosols among biowaste collectors and compost workers. *Occup. Environ. Med. 57(7):* 458. Sigsgaard, T. 1999. Health hazards to waste management workers in Denmark. *Schriftenr ver Wassen Boden Lufthyg.104:* 563. Sigsgaard, T. et al. 1994. Lung function changes among recycling workers exposed to organic dust. *Amer. J. of Ind. Med. 25:* 69. Sigsgaard, T. et al. 1994. Respiratory disorders and atopy in Danish refuse workers. *Am. J. Respir. Crit. Care Med. 149:* 1407.

Overall, studies of compost workers indicate:

While mycotoxin-contaminated dust in farm workers has shown hepatocellular carcinoma and mycotoxicoses of the lung, long-term epidemiological studies have not yet been conducted in compost workers, so it is unknown if they will experience similar problems.

However, it has been postulated that a similar, if not higher, exposure can be assumed for workers in compost facilities.

Chemical and biological hazards

- Volatile organic and inorganic compounds
  - Carbon dioxide
  - MVOCs produced by bacteria or fungi; with typical chemical profiles for individual species
  - Ammonia: can exceed OSHA limits in enclosed facilities
  - Nitrous oxide
  - Methane: if pile anaerobic for a long time

Fischer, G. et al. 1998. Airborne fungi and their secondary metabolites in working places in a compost facility. *Mycoses 41(9-10):* 383.
Fischer, G. et al. 1999. Species-specific production of microbial volatile organic compounds (MVOC) by airborne fungi from a compost facility. *Chemosphere 39(5):* 795.

Chemical and biological hazards

- Endotoxins; mycotoxins; organic dusts (dead organisms)
- Non-compostables: metals, organics

Fischer, G. et al. 1998. Airborne fungi and their secondary metabolites in working places in a compost facility. *Mycoses 41(9-10):* 383.
Fischer, G. et al. 1999. Species-specific production of microbial volatile organic compounds (MVOC) by airborne fungi from a compost facility. *Chemosphere 39(5):* 795.

Carbon dioxide

in poorly aerated areas of buildings or in a confined space (such as in-vessel composting) may reach levels which could affect those with pre-existing heart conditions

Volatile emissions: hazard or nuisance odor?

- Volatile organic compounds: including short-chain volatile fatty acids, ketones, and aldehyes
- Reduced sulfur compounds: including hydrogen sulfide, carbon disulfide
- Ammonia

Peterson, M. K. et al. 2000. Characterization of emissions from two yard-waste composting facilities.

Epstein, E. et al. 2000. Odors and volatile organic compound emissions from composting facilities.

Volatile emissions: hazard or nuisance odor?

Most common odorants in facilities across the US:

- Hydrogen sulfide
- Dimethyl disulfide
- Dimethyl sulfide
- Dimethyl trisulfide
- Acetophenone
- Ammonia

Aromatic oils from wood chips (bulking agent):

- Limonene
- a-pinene, b-pinene

Volatile emissions: hazard or nuisance odor?

Typically, odors are the greatest deterrent to siting and maintaining composting facilities as nearby residents tend to associate odor with adverse health effects, especially headaches.

These have led to facility closure, litigation, and difficulty siting new facilities.

"Do your stuff — you're on microscope."

Biological exposures

- Bacteria: infectious risk in initial phase of composting; may not be significant risk in final processing if system operates to kill pathogens (possible exception of *C. botulinum*).

Endotoxin exposure potential at levels which may decrease lung function, but existing studies suggest fungal toxins may be more useful measure.

Watanabe, T. et al. 2002. Risk evaluation for pathogenic bacteria and viruses in sewage sludge compost. *Water Sci. Technol. 46 (11-12):* 325.

Biological exposures

- Fungi: allergens and toxic products; acute or chronic effects in susceptible people. The effects of long-term exposure to toxins is unknown; few exposure studies have been done for the qualities and quantities of toxins in airborne dusts and bioaerosols.

Watanabe, T. et al. 2002. Risk evaluation for pathogenic bacteria and viruses in sewage sludge compost. *Water Sci. Technol. 46 (11-12):* 325.

Biological exposures

- Viruses: poor survivability in sewage sludge compost (inactivated)
- Protistans (protozoal parasites)
- Animals: worm cysts
- Prions

Watanabe, T. et al. 2002. Risk evaluation for pathogenic bacteria and viruses in sewage sludge compost. *Water Sci. Technol. 46 (11-12):* 325.

Exposure to Fungi

Up to 100 species have been found in compost. Seasonal changes in predominant species; but typically *Aspergillus* and *Penicillium* spp.

Total fungi typically reported at 10^6 – 10^7 CFU/m^3 of air in compost pile hall and loading area; could be higher for short periods in some areas.

With 10^3 – 10^4 for levels of individual species

In a compost pile hall, airborne total levels tend to stay consistent due to relatively constant climatic conditions of temperature and relative humidity

Fischer, G. et al. 1999. Mycotoxins of *Aspergillus fumigatus* in pure culture and in native bioaerosols from compost facilities
Fischer, G. et al. 1998. Airborne fungi and their secondary metabolites in working places in a compost facility. *Mycoses 41(9-10):* 383..
Chemosphere 38(8): 1745.

Fungi can cause hypersensitivity

- Immediate-type allergic reactions: asthma, hay fever (sometimes fungal colonization of mucous secretions)

Sensitivity to fungi is high in childhood and declines rapidly with age, suggesting that younger children may be less proficient in clearing fungal particles from the airways.

Among non-asthmatics, sensitization to fungal spores can occur with repeated exposure to high spore concentrations.

- Hypersensitivity pneumonitis

Fungi can cause infections

Most fungi commonly encountered in the environment are unable to cause infectious disease unless the exposed person is immunodeficient.

Such as: *Aspergillus fumigatus, Monilia* spp., *Candida* spp.,*Penicillium* spp., *Mucor* spp.

Fungi can cause infections

Persons with compromised host defenses may include:

- diabetes
- cancer (especially leukemia)
- cystic fibrosis
- alcoholism
- inherited immune deficiency
- acquired immune deficiency (AIDS)
- burns, skin cuts, abrasions, or other trauma
- invasive medical procedures
- certain medications (some antibiotics and immunosuppressive drugs)

Fungi can produce toxic effects

- Mycotoxins: mucous membrane irritation, skin rash, dizziness, nausea, immunosuppression, birth defects, and cancer (literature has focused on ingestion, rather than inhalation)
- Glucans: comprise the bulk of the cell walls of most fungi; irritants
- Volatile organic compounds: produced during growth and degradation of substrates; some with distinctive odor and low odor threshold; nonspecific illnesses

Fungi

- *Aspergillus fumigatus*: always present in composting sludge, especially during the thermophilic phase; believed originating from wood chips
- *Penicillium*
- *Stachybotrys:* found in facility composting old wood

These 3 genera have very small spores which can penetrate into the deep lung causing local inflammatory, toxic, and allergenic responses; pneumonitis; organic toxic dust syndrome; bronchitis; and asthma.

Marsh, P. B. et al. 1979. A guide to the recent literature on Aspergillosis as caused by *Aspergillus fumigatus*, a fungus frequently found in self-heating organic matter. *Mycopathologia 69(1-2):* 67.

Potential causative agents of…

…an inflammatory reaction in the airways and reduced lung function:

- Endotoxin from gram-negative bacteria
- Lipopolysaccharides and glucans from fungi
- Allergens from microorganisms or their spores

…irritation of the eyes, nose, and throat; lethargy, and headache:

- MVOCs

Source: Fischer, G. et al. 1998. Airborne fungi and their secondary metabolites in working places in a compost facility. *Mycoses 41(9-10):* 383. Sigsgaard, T. et al. 2000. Cytokine release from the nasal mucosa and whole blood after experimental exposures to organic dusts. *Eur. Respir. J. 16*: 140. Bunger, J. et al. 2000. Health complaints and immunological markers of exposure to bioaerosols among biowaste collectors and compost workers. *Occup. Environ. Med. 57(7):* 458. Sigsgaard, T. 1999. Health hazards to waste management workers in Denmark. *Schriftenr ver Wassen Boden Lufthyg.104:* 563. Sigsgaard, T. et al. 1994. Lung function changes among recycling workers exposed to organic dust. *Amer. J. of Ind. Med. 25:* 69.

Principal hazards

- Noise: OSHA regulation

Source: Johanning, E. 1999. An overview of waste management in the United States and recent research activities about composting related occupational health risk. *Schriftenr ver Wassen Boden Lufthyg. 104:* 127.

What is noise?

Sound is any pressure variation (in air, water, or other medium) that the human ear can detect.

Noise is usually defined as sound that bears no information and whose intensity usually varies randomly in time. Often considered unpleasant and can interfere with wanted sound. Only human reaction can distinguish between a sound and a noise.

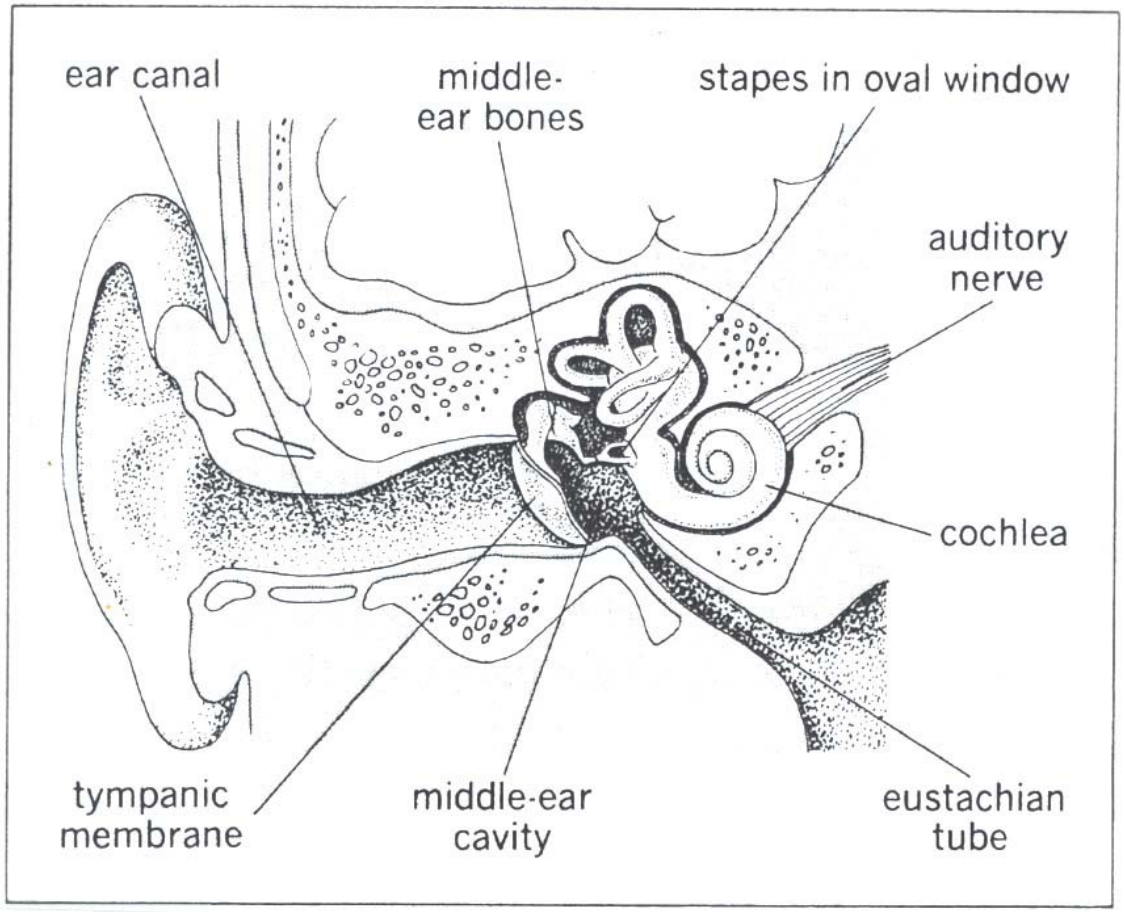
Sound is perceived by hearing; vibration by touch or feeling (but no real physical difference between them).

Frequency

Frequency is perceived as pitch. Humans can hear between 20 and 20,000 Hz. (Hz is hertz, a cycle per second)

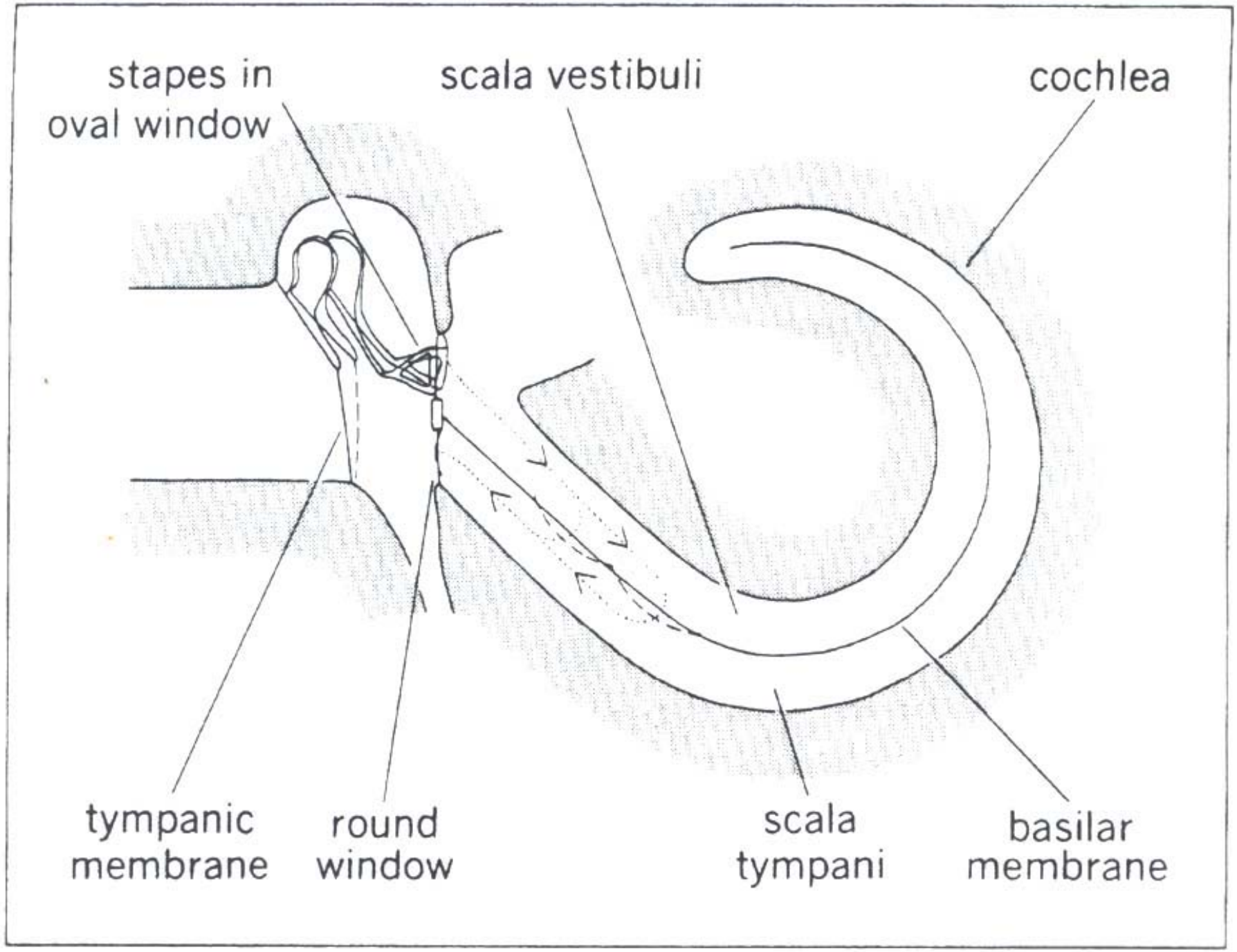
Loudness is primarily dependent on sound pressure, but is also affected by frequency.

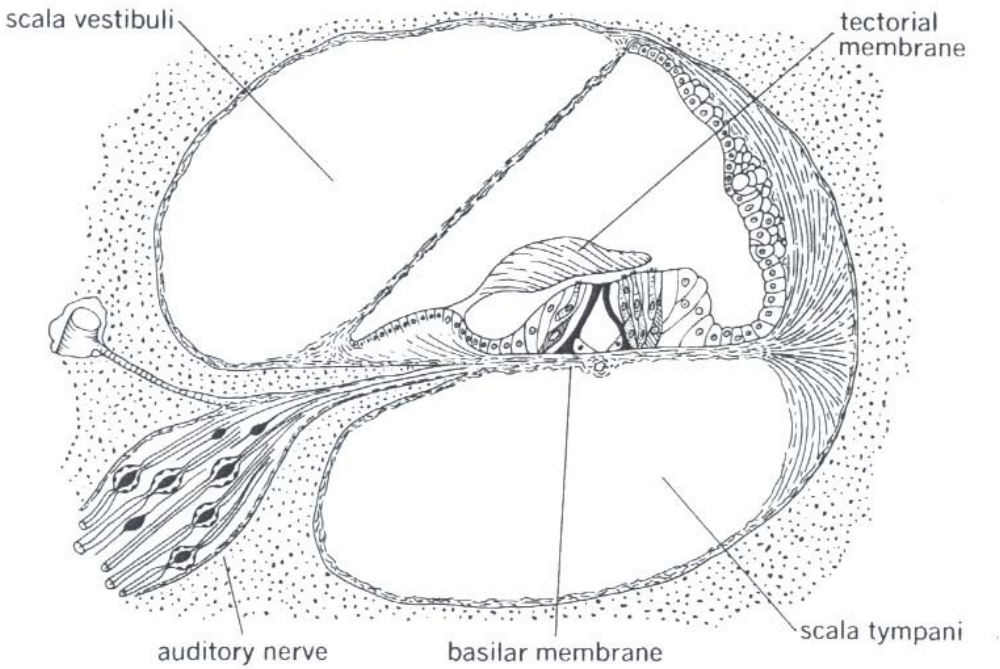
Most sounds contain a spectrum of frequencies. Usually high-frequency noise is more annoying (and usually more harmful) than low-frequency noise. Frequencies above 500 Hz have the greater potential for causing hearing loss.

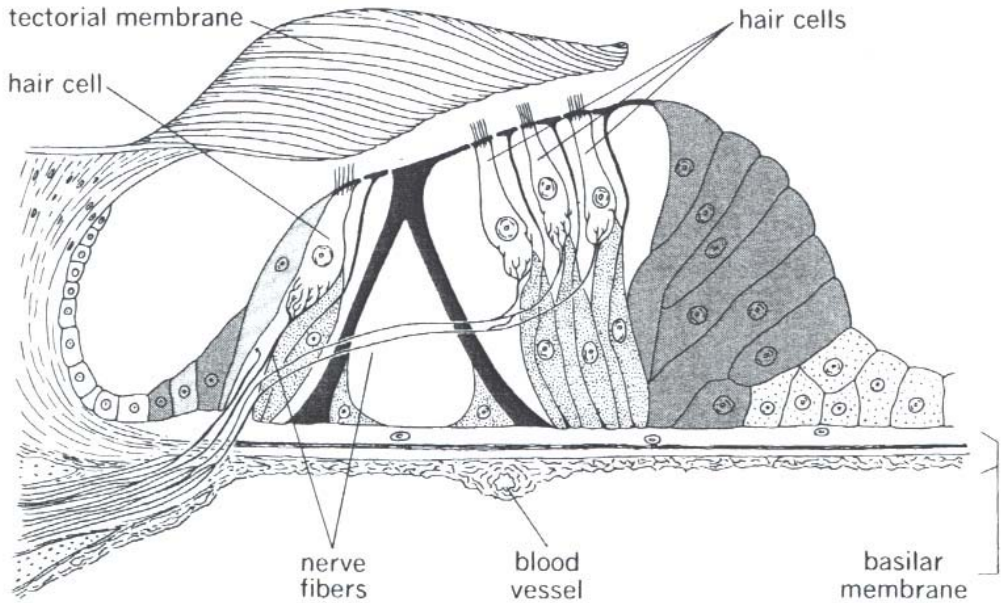


Anatomy of the human ear.

Source:
Vander, A. J. et al. 1970. Human physiology: mechanisms of body function. McGraw-Hill Book Co. New York.


stapes in
oval window
scala vestibuli
cochlea
tympanic
membrane
round
window
scala
tympani
basilar
membrane





USDOL. OSHA. 29 CFR 1910.95 Occupational noise exposure

Permissible Noise Exposures	
Duration Per Day (hours)	*Sound Level, Slow Response (dBA)*
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼ or less	115

Every 5 dBA increase in noise level cuts the allowable exposure time in half. It is currently believed that exposure of the unprotected ear to levels above 115 dBA is hazardous.

Examples of Noise

Equipment used for…

- wood chipping
- shredding
- grinding
- turning piles

…reported as exceeding 90 dBA

Shredders reported as high as 98 dBA

Source: USEPA. 1994. *Composting yard trimmings and municipal solid waste.* EPA 530-R-94-003.

Table 9–B. Sound Pressure and Sound Pressure Level Values for Some Typical Sounds

Sound Pressure (μPa)	*Overall Sound Pressure Level* (*dB, re: 20* μPa)	*Example*
20	0	Threshold of Hearing
63	10	
200	20	Studio for sound pictures
630	30	Soft whisper (5 feet)
2,000	40	Quiet office; Audiometric testing booth
6,300	50	Average residence; Large office
20,000	60	Conversational speech (3 ft)
63,000	70	Freight train (100 ft)
200,000	80	Very noisy restaurant
630,000	90	Subway; Printing press plant
2,000,000	100	Looms in textile mill; Electric furnace area
6,300,000	110	Woodworking; Casting shakeout area
20,000,000	120	Hydraulic press; 50-HP siren (100 ft)
200,000,000	140	Threshold of pain; Jet plane
20,000,000,000	180	Rocket-launching pad

A change of sound pressure by a factor of 10 corresponds to a change in sound pressure level of 20 dB.

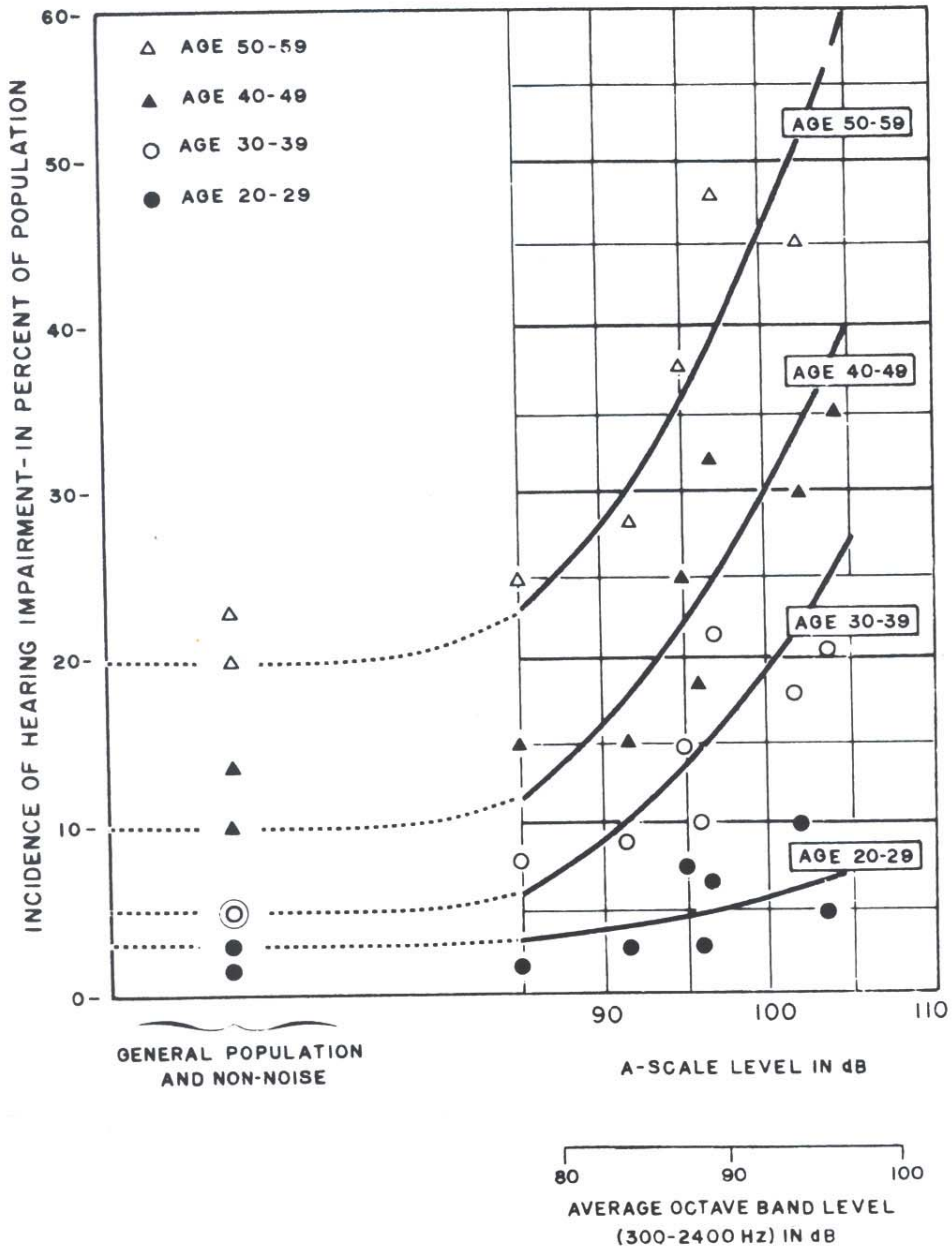


Figure 9–9. The incidence of hearing impairment in the general population and in selected populations by age group and by occupational noise exposure.

"The devil with the food chain. I *like* mercury."

Principal hazards – an overview

- Climatic conditions: heat or cold stress; NIOSH/ACGIH recommendations

Source: Johanning, E. 1999. An overview of waste management in the United States and recent research activities about composting related occupational health risk. *Schriftenr ver Wassen Boden Lufthyg. 104:* 127.

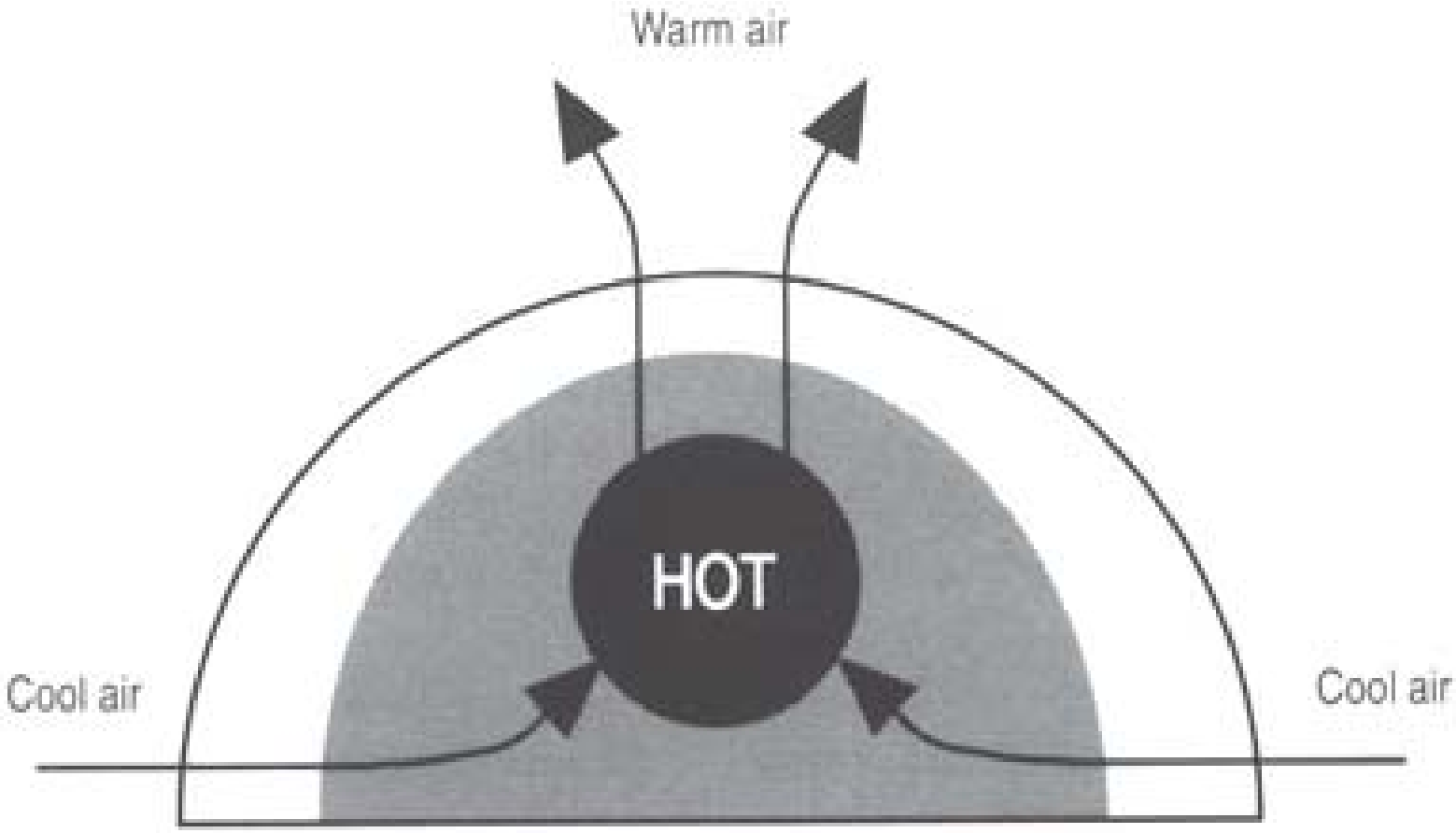


Figure 2.2
Natural (passive) air movement in a composting windrow or pile.

Source: Richard and Dickson, *Municipal Yard Waste Composting: An Operator's Guide.*

Source: Rynk, R. 1992. *On-Farm Composting Handbook.* National Resource, Agriculture, and Engineering Service. Cooperative Extension. Ithaca, NY.

Thermal Stress

Heat stress exercise

Cold stress exercise

Heat Stress

Fluid replacement: drink small quantities frequently (5 – 7 ounces every 15 – 20 minutes), do not depend upon thirst as a warning.

Source:
Bernard, T. E. 1996. "Thermal stress," in: Plog, B. A. et al. *Fundamentals of industrial hygiene.* National Safety Council. Itasca, IL.
USDHHS/NIOSH. 1992. *Working in hot environments.* Superintendent of Documents. U.S. Government Printing Office. Washington, DC. 20402.

Principal hazards – an overview

- Accidents and trauma (including sharp objects in compost): OSHA regulations

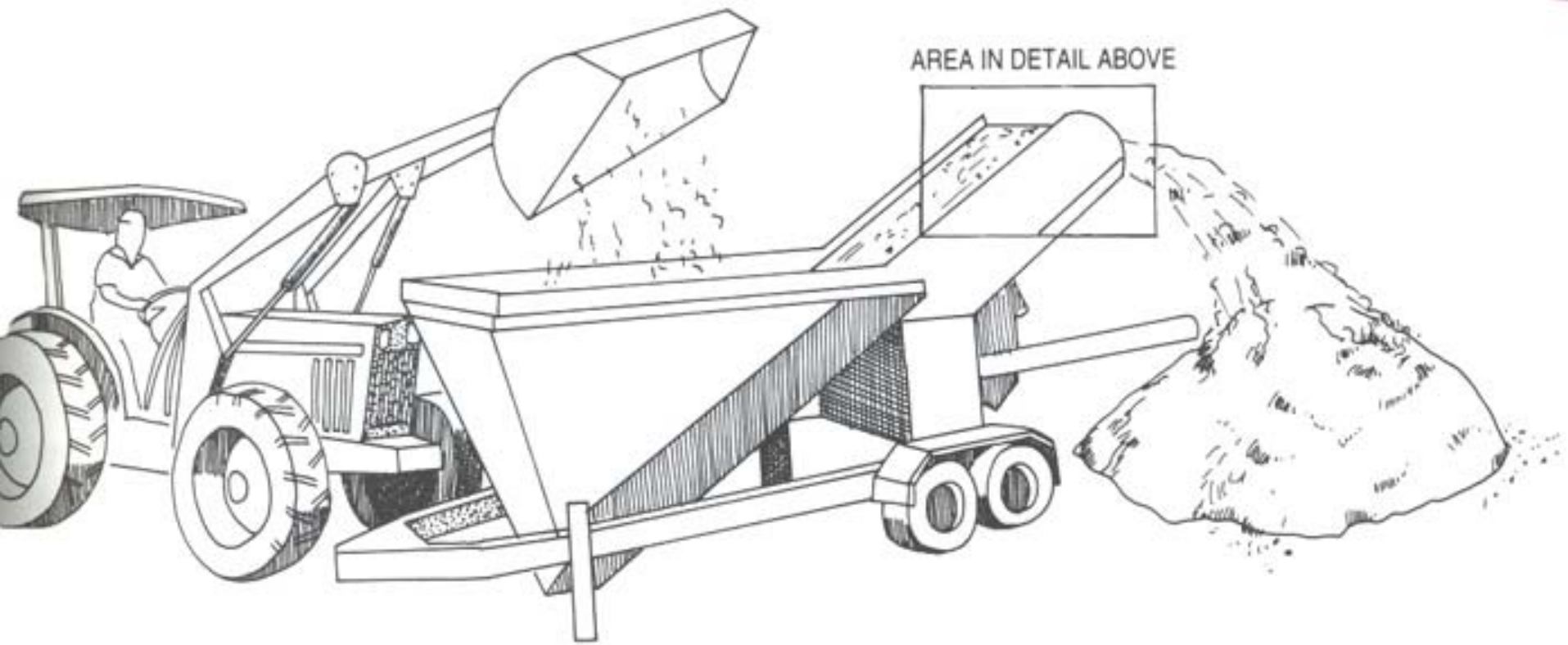
Source: Johanning, E. 1999. An overview of waste management in the United States and recent research activities about composting related occupational health risk. *Schriftenr ver Wassen Boden Lufthyg. 104:* 127.

Accidents and Trauma Risks

- In buildings or from windrows, mists from evaporating moisture might visually obscure workers
- Brush chipper accidents
- Conveyor belt accidents
- Grinders, turners, and mixers
- Power take-offs from tractors

USDHHS/CDC/NIOSH. 1999. Worker dies due to a fall from a conveyor belt. Ohio FACE Report No. 99OH02301.
USDHHS/CDC/NIOSH. 1996. Independent contractor dies when struck by protective hood from chipper/shredder at waste management facility in Massachusetts. Massachusetts FACE Report No. 96MA037.

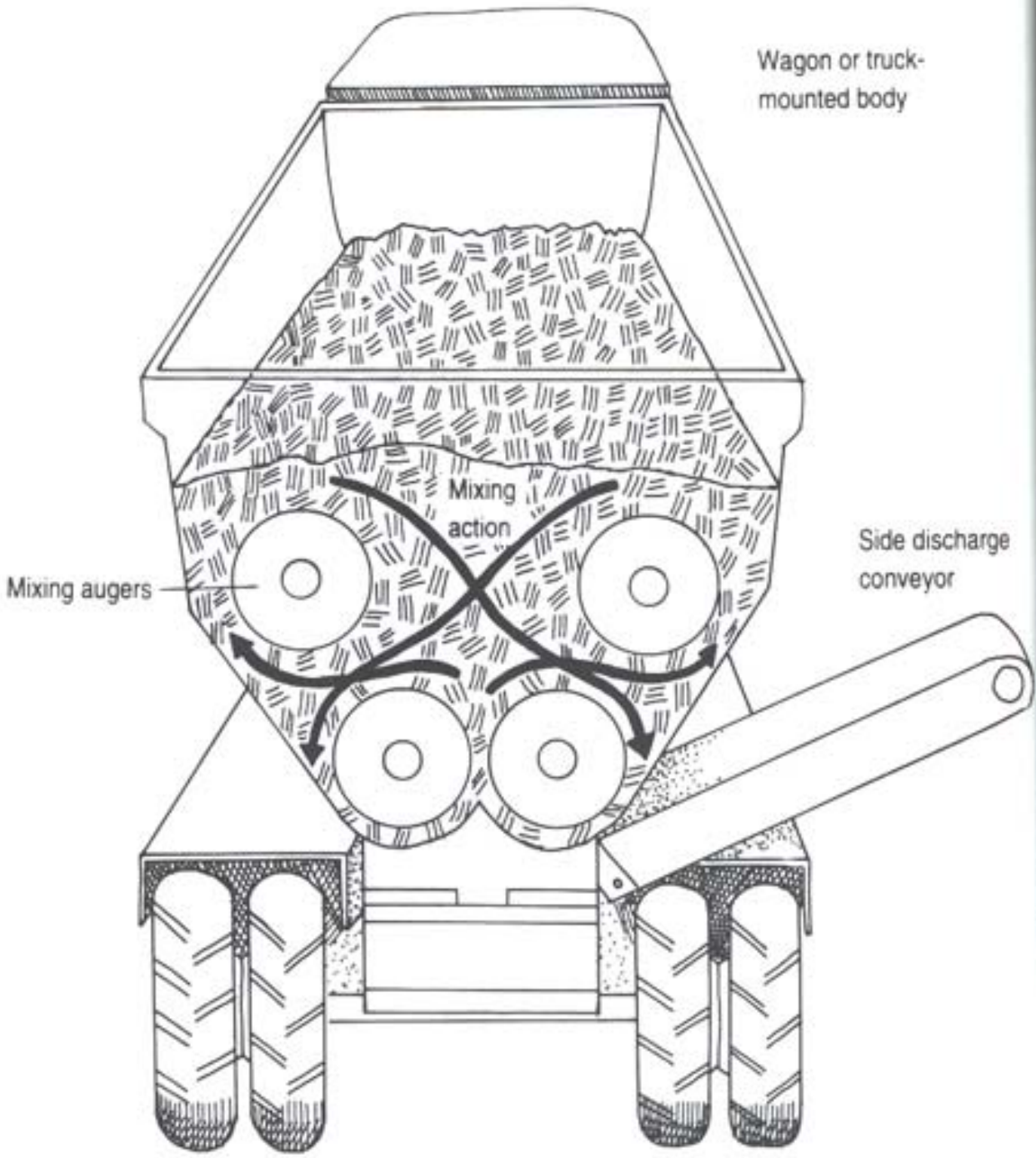
Belt-type shear shredder



Source: Rynk, R. 1992. *On-Farm Composting Handbook.* National Resource, Agriculture, and Engineering Service. Cooperative Extension. Ithaca, NY.

Batch mixer

Source: Rynk, R. 1992. *On-Farm Composting Handbook.* National Resource, Agriculture, and Engineering Service. Cooperative Extension. Ithaca, NY.



Rotary shear shredder

Source: Rynk, R. 1992. *On-Farm Composting Handbook*. National Resource, Agriculture, and Engineering Service. Cooperative Extension. Ithaca, NY.

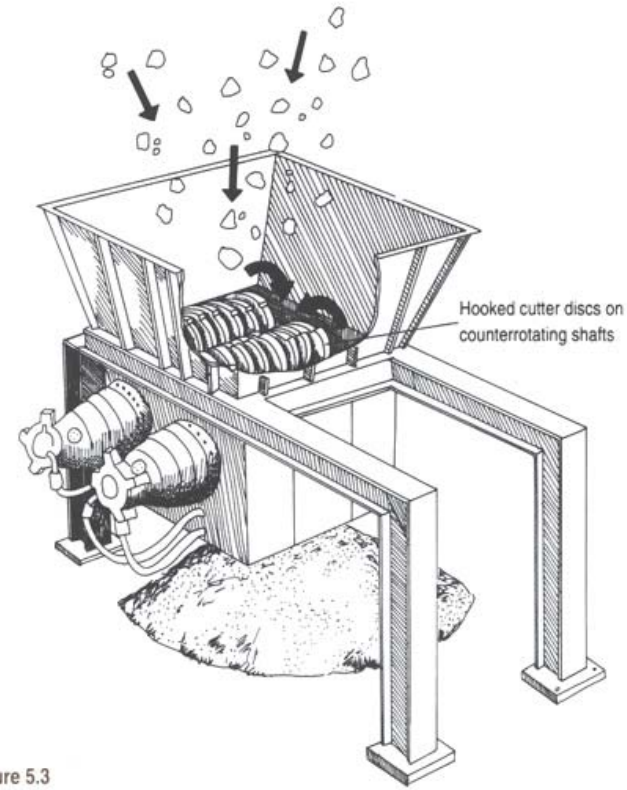


Figure 5.3
Rotary shear shredder.
Adapted with permission from Triple/S Dynamics.

Hammer mill

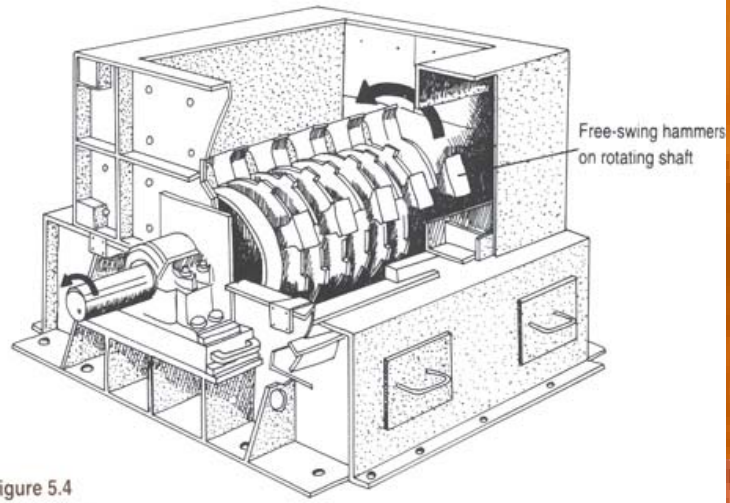


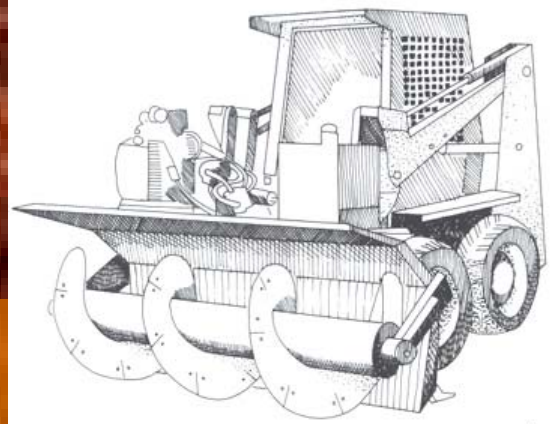
Figure 5.4
Hammer mill.

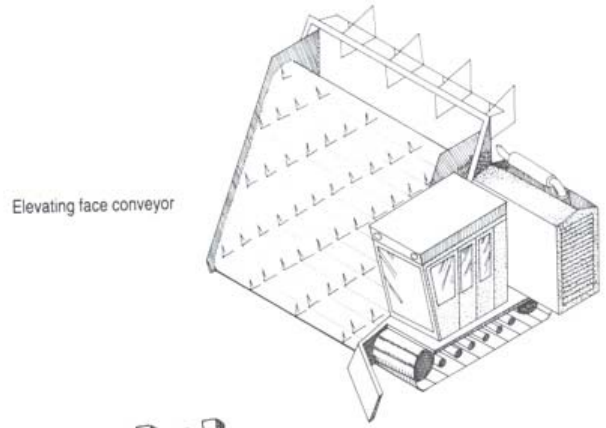
Augur turner

Elevating face conveyor

Rotary drum with flails

Source: Rynk, R. 1992. *On-Farm Composting Handbook.* National Resource, Agriculture, and Engineering Service. Cooperative Extension. Ithaca, NY.





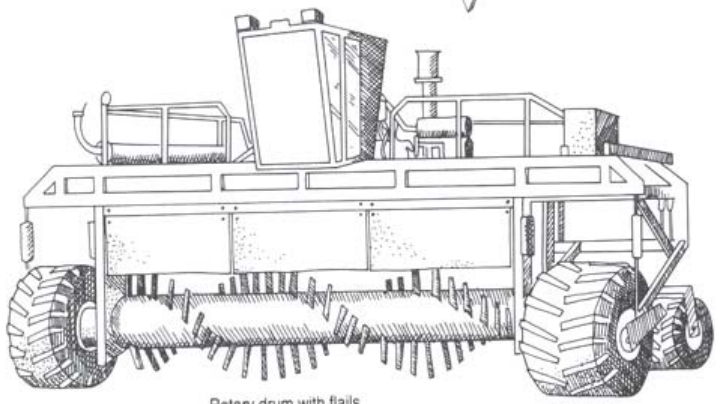
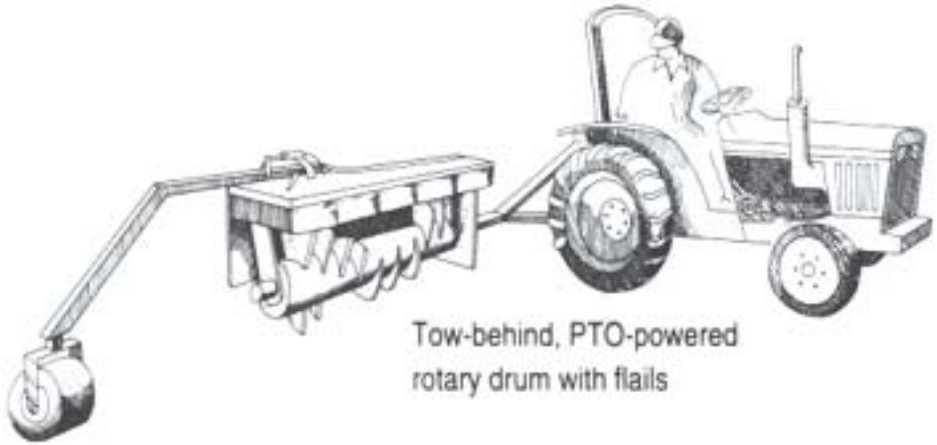


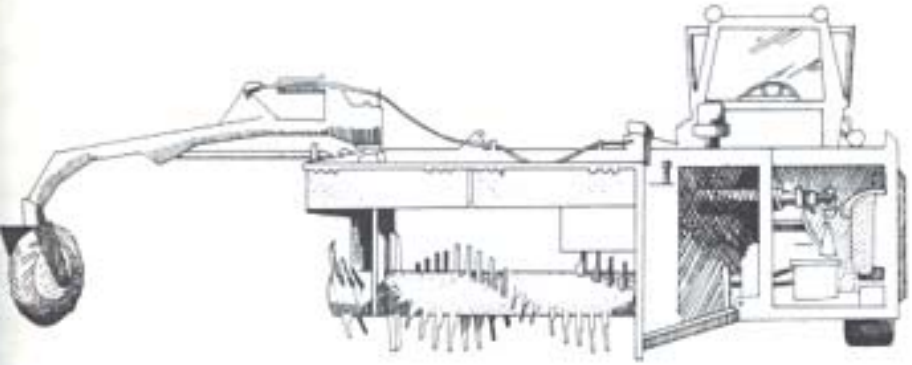
Figure 4.6
Self-powered and self-driven windrow turners.

Auger turner is adapted with permission from Brown Bear Corporation. Rotary drum with flails is adapted from Richard, Dickson, and Rowland, *Yard Waste Management.*

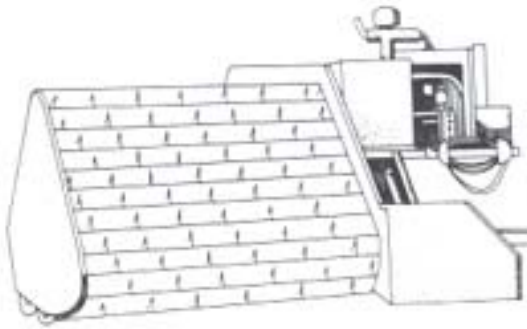
Source: Rynk, R. 1992. *On-Farm Composting Handbook.* National Resource, Agriculture, and Engineering Service. Cooperative Extension. Ithaca, NY.



Tow-behind, PTO-powered rotary drum with flails



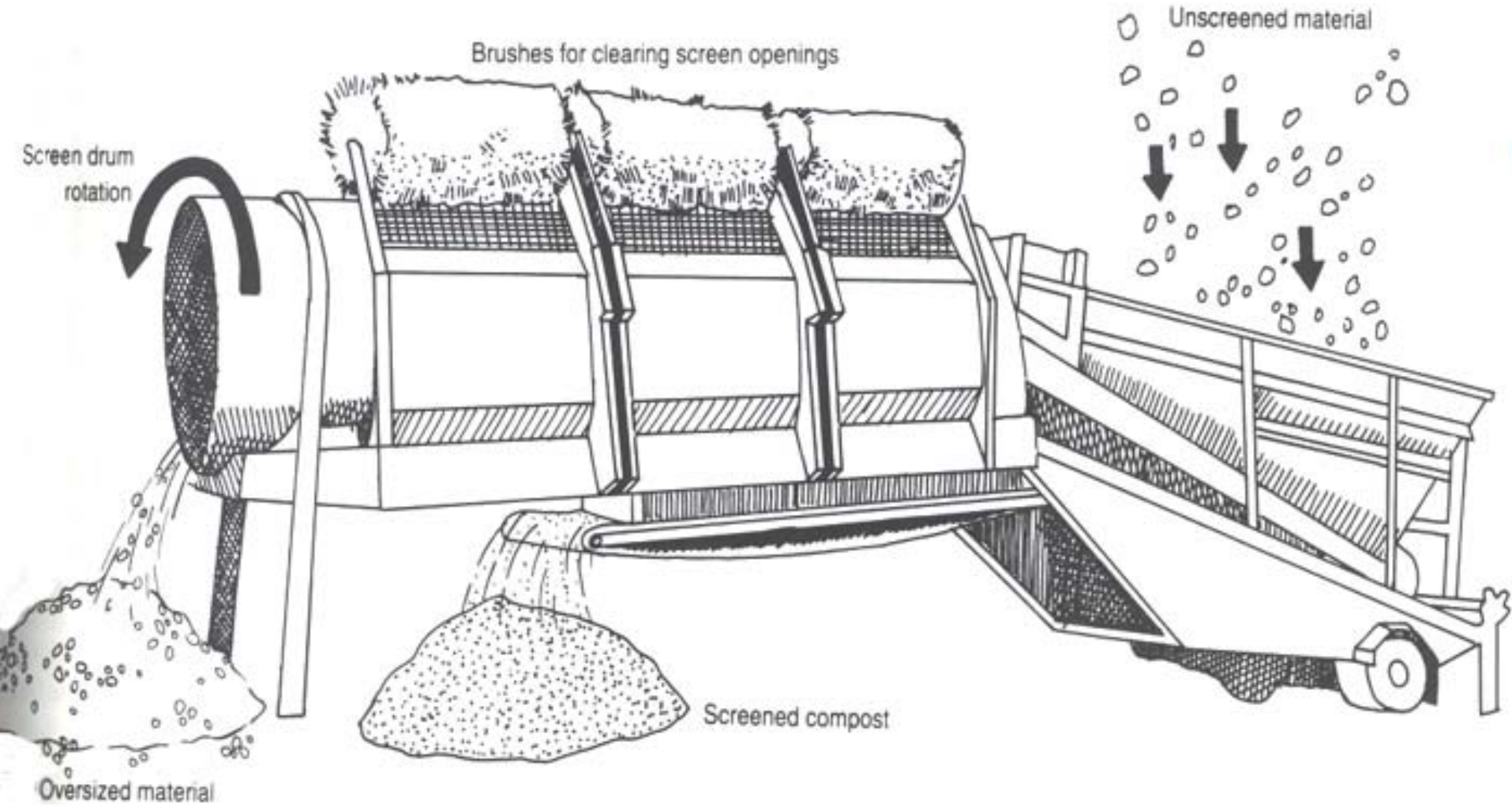
Push-type, self-powered (diesel engine) rotary drum with flails



Tractor-towed, self-powered, elevating-face conveyor

Figure 4.4
Tractor-assisted windrow turners.

Elevating-face conveyor is adapted with permission from Scat Engineering. Rotary drum turner is adapted with permission from Wildcat Manufacturing.



Trommel screen

Source: Rynk, R. 1992. *On-Farm Composting Handbook.* National Resource, Agriculture, and Engineering Service. Cooperative Extension. Ithaca, NY.

Tub grinder

Source: Rynk, R. 1992. *On-Farm Composting Handbook.* National Resource, Agriculture, and Engineering Service. Cooperative Extension. Ithaca, NY.

Source: Rynk, R. 1992. *On-Farm Composting Handbook.* National Resource, Agriculture, and Engineering Service. Cooperative Extension. Ithaca, NY.

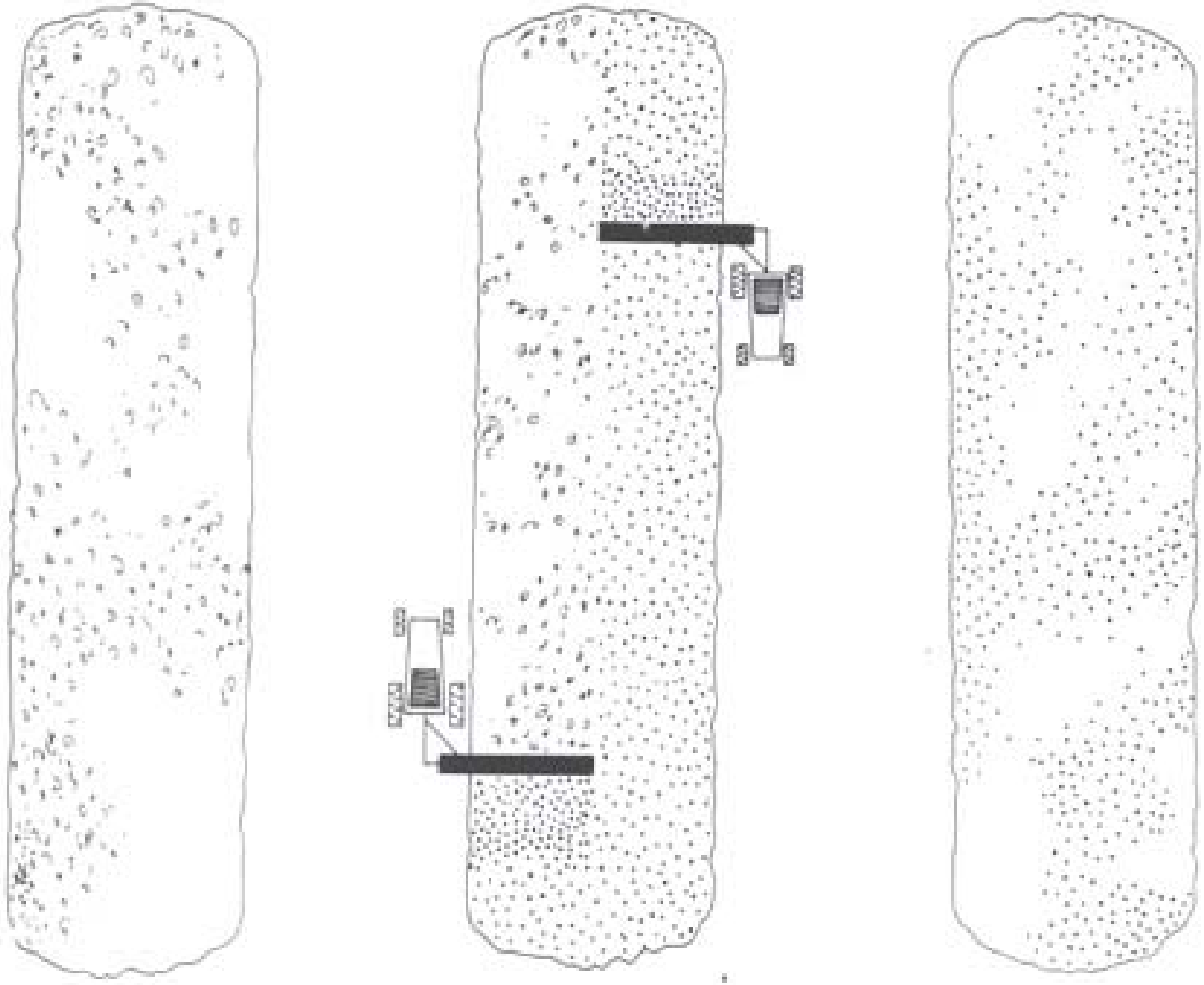


Figure 4.5
Two passes are necessary for most tractor-drawn turners.

How can we reduce exposure?

Product or process substitution?

Engineering controls?

Administrative controls?

Personal protective equipment?

Worker exposure is reflected in process control

Process control and worker exposure appear to be inextricably interrelated.

It is probably true that the better quality our composting operation…

…the lower our workers' exposure and

…the more consistent and well-defined that exposure is.

Epstein, E. et al. 2000. Odors and volatile organic compound emissions from composting facilities.

Product or process substitution

Do we compost or do something else?

If so, how do we compost?

- windrow
- static pile
- in-vessel
- vermicomposting
- other(?)

Examples of engineering controls

- Negative v. positive aeration?
- Windrow v. aerated static pile?
- Scrubbers or biofilters; using corrosion-resistant blowers and ducting
- Minimize headspace in the building to reduce air quantity to be treated

Epstein, E. et al. 2000. Odors and volatile organic compound emissions from composting facilities.

Examples of work practices

- Adequate insulation layers on piles
- Timely mixing of fresh feedstocks; at least 40% solids to maintain aerobic conditions; rapid incorporation of sludge or fish waste
- Carbon-to-nitrogen ratio kept high (30:1 is ideal) to prevent alkaline conditions and slow degradation producing ammonia
- Proper and uniform aeration of piles; avoid early morning or late afternoon; note weather conditions such as temperature inversions

Epstein, E. et al. 2000. Odors and volatile organic compound emissions from composting facilities.

Examples of work practices

MOISTURE CONTROL:

- Frequent spraying of water during turning of bed to reduce airborne dusts
- Stored product too dry, slowing microbial activity

Examples of administrative controls

- Scheduling and job rotation
- Training: on processes, hazards, hygiene practices, signs and symptoms
- Monitoring (air, medical)
- Hygiene practices

Hygiene Practices

- Hygiene facilities: change rooms, showers, clean-up, lunchroom
- Shower at work and change into clean clothes and shoes. Reserve footgear for use at worksite.
- Wash hands with soap and water before eating or smoking or whenever hands come into contact with compost or feed stocks.
- Wash hands before and after using the bathroom.

USDHHS/CDC/NIOSH. 2002. Guidance for controlling potential risks to workers exposed to class B biosolids. DHHS (NIOSH) Publication No. 2002-149.

Hygiene Practices

- Do not wear clothes home or outside the work environment.
- Remove excess contaminants from footgear prior to entering a vehicle or a building.
- Thoroughly but gently flush eyes with water if contaminants contact the eyes.
- Care for cuts and abrasions promptly. Keep wounds covered with clean, dry bandages.

Slavin, R. G. et al. 1977. Epidemiologic aspects of allergic aspergillosis. *Ann. Allergy 38(3):* 215.

Air monitoring considerations: controversial for biological hazards

- Lack of occupational exposure limits
- Average v. peak airborne exposure
- Total v. inhalable aerosol exposure
- Microbial variability
- Viable v. total microorganisms
- Static area air sampling v. personal air sampling
- Synergistic interactions between components of bioaerosol exposure
- Individual susceptibility

Source: Poulsen, O. M. et al. 1995. Sorting and recycling of domestic waste. Review of occupational health problems and their possible causes. *Sci. Total Environ. 168*: 33.

Medical monitoring considerations

Two on-going 3-year studies involving extensive medical monitoring should be able to reveal the specific parameters that will be most useful.

In the meantime, the monitoring recommended for sewer and wastewater workers could be useful.

Also, keep current the vaccinations recommended by the CDC for the general population. If sewage sludge exposure, also consider hepatitis A vaccine.

Source: Poulsen, O. M. et al. 1995. Sorting and recycling of domestic waste. Review of occupational health problems and their possible causes. *Sci. Total Environ. 168*: 33.

Personal protective equipment

- **Respiratory protection for all the dust-generating tasks (particulates)**
- **Unvented goggles; can add faceshield if impact possible**
- **Gloves and steel-toed workshoes; for wet feedstocks use heavy duty rubber gloves and boots**
- **Use protective clothing; moisture-proof for wet feedstocks**
- **Hardhat**

Rautiala, S. et al. 2003. Farmers' exposure to airborne microorganisms in composting swine confinement buildings. *AIHAJ 64*: 673.
Curtis, L. et al. 1998. Characterization of bioaersol emissions from a suburban yard waste composting facility. *Proceedings of 4th International Conference on Bioaerosols, Fungi, Bacteria, Mycotoxins, and Human Health.* Saratoga Springs, NY. September 23 – 25, 1998.
American Conference of Governmental Industrial Hygienists. 1999. *Bioaerosols: assessment and control*. American Conference of Governmental Industrial Hygienists. Cincinnati, OH. USEPA. 2001. *Mold remediation in schools and commercial buildings*. EPA 402-K-01-001. http://www.epa.gov

Personal protective equipment

Remove contaminated clothing at end of shift. Avoid laundering work clothes at home.

If they are cleaned at home, place them in a bag and leave them bagged until they are actually to be placed in the washing machine. Wash separately from other clothing using the hot water cycle. Use chlorine bleach if appropriate for the fabric.

Rautiala, S. et al. 2003. Farmers' exposure to airborne microorganisms in composting swine confinement buildings. *AIHAJ 64*: 673.
Curtis, L. et al. 1998. Characterization of bioaersol emissions from a suburban yard waste composting facility. *Proceedings of 4th International Conference on Bioaerosols, Fungi, Bacteria, Mycotoxins, and Human Health.* Saratoga Springs, NY. September 23 – 25, 1998.

What about high-risk workers: such as occupational asthma to fungi or immunocompromised?

Could they work at composting facilities?

Consider aspects of the Americans with Disabilities Act:

- Reasonable accommodation
- Direct threat to safety of him/herself or others

Harber, P. et al. 1994. Work placement and worker fitness: implications of the Americans with Disabilities Act for pulmonary medicine. *Chest 105:* 1564.
Harber, P. et al. 1993. Accommodating respiratory handicap. *Seminars in Respiratory Medicine 14(3):* 240.

“Direct threat” based upon:

- likelihood (probability) that an injury will occur; this is high probability not just elevated risk or a remote or speculative risk
- certainty (predictability) that an injury will occur; especially based upon individual factors

Determining significant risk of substantial harm

- **probability** -- the statistical likelihood of the harm occurring
- **severity** -- the nature and severity of the potential harm
- **imminence** -- the time frame in which the harm is likely to occur
- **duration** -- how long the risk is likely to be present

The employer must determine that all reasonable accommodation would not reduce risk to acceptable levels.

Sources:
St. Clair, S. et al. 1992. Americans with Disabilities Act: Considerations for the practice of occupational medicine. *J. of Occup. and Environ. Med. 34(5):* 510. Boden, L. I. et al. 1995. Company characteristics and workplace medical testing. *Amer. J. of Public Health 85(8):* 1070. Rothstein, M. A. 1996. Legal and ethical aspects of medical screening. *Occup. Med.: State of Art Rev. 11(1):* 31.

In general…

…Educated workforce

…Good process control

…Meet occupational standards where they exist; recommendations where there are no regulations

…Good hygiene

…Proper protective equipment

Source: Sigsgaard, T. 1999. Health hazards to waste management workers in Denmark. *Schriftenr ver Wassen Boden Lufthyg.104:* 563.